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THE PHILIPPINE
AGRICULTURAL REVIEW

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1921
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The Philippine

Agricultural Review

VOL. XIV FIRST QUARTER, 1921 No. 1

RICE NUMBER

A QUARTERLY PUBLICATION

ISSUED IN ENGLISH BY THE
BUREAU OF AGRICULTURE

The Government of the Philippine Islands
Department of Agriculture and Natural Resources

Subscription rates: ₱2 (Philippine currency) or $1 (U. S. currency) per annum in the Philippine Islands and the United States and territories.
$2 (U. S. currency) per annum in foreign countries.

MANILA
BUREAU OF PRINTING
1920

(Entered at the Post Office at Manila as second-class matter)

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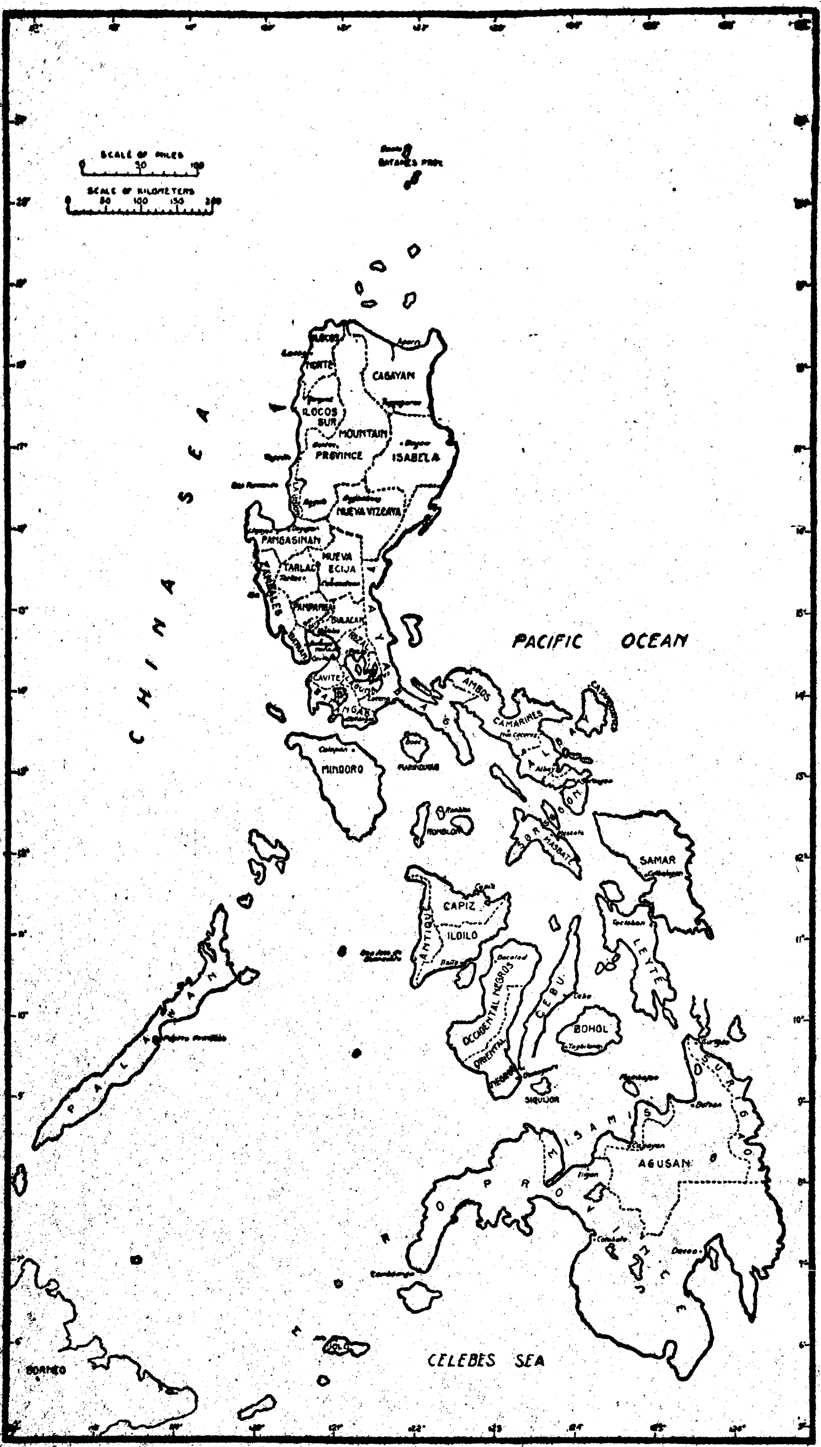
1921
no.14



TRANSPLANTING LOWLAND RICE WITH A GUITARIST TO TIME AND SPEED UP THE WORK

THE PHILIPPINE

Agricultural Review

VOL. XIV FIRST QUARTER, 1921 No. 1

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EDITORIAL

"Agriculture—the tilling of the soil—is not only the sole real title to a soil but the only means of permanently holding it. Thus if the Red Indians had learnt agriculture from the first European settlers in North America they would soon have been numerous enough to bar all progress west. And conversely, though the Indians of Mexico, Central America, Peru, and other South American States were atrociously treated, they could not be exterminated because of the numbers which the pursuit of agriculture had won for them. That the tilling of the soil is in the last analysis the best title to that soil in the face of all odds, is self-evident."

And moreover that the branch of agriculture it is most necessary for a country to engage in is the raising of its main food crop, is substantially what it is reasonable to expect the author of the above would have advanced as a second axiom, had he continued. Having crops to export of other kinds, no matter how valuable and abundant these may be, does not excuse a country if it falls short in its obligation to feed its own people from its own soil.

The Philippines has been for many years open to this very charge, for the annual importations of rice have been extremely heavy. However, there is no indifference or complaisance over this state of affairs in the Islands; there has been effort all the time on the part of Government, press, and people, to remedy the situation, the most encouraging feature of which seems to us the fact that our young men have turned and are turning to the study of agriculture in such yearly increasing numbers, devoting themselves whole-heartedly to the service of the soil.

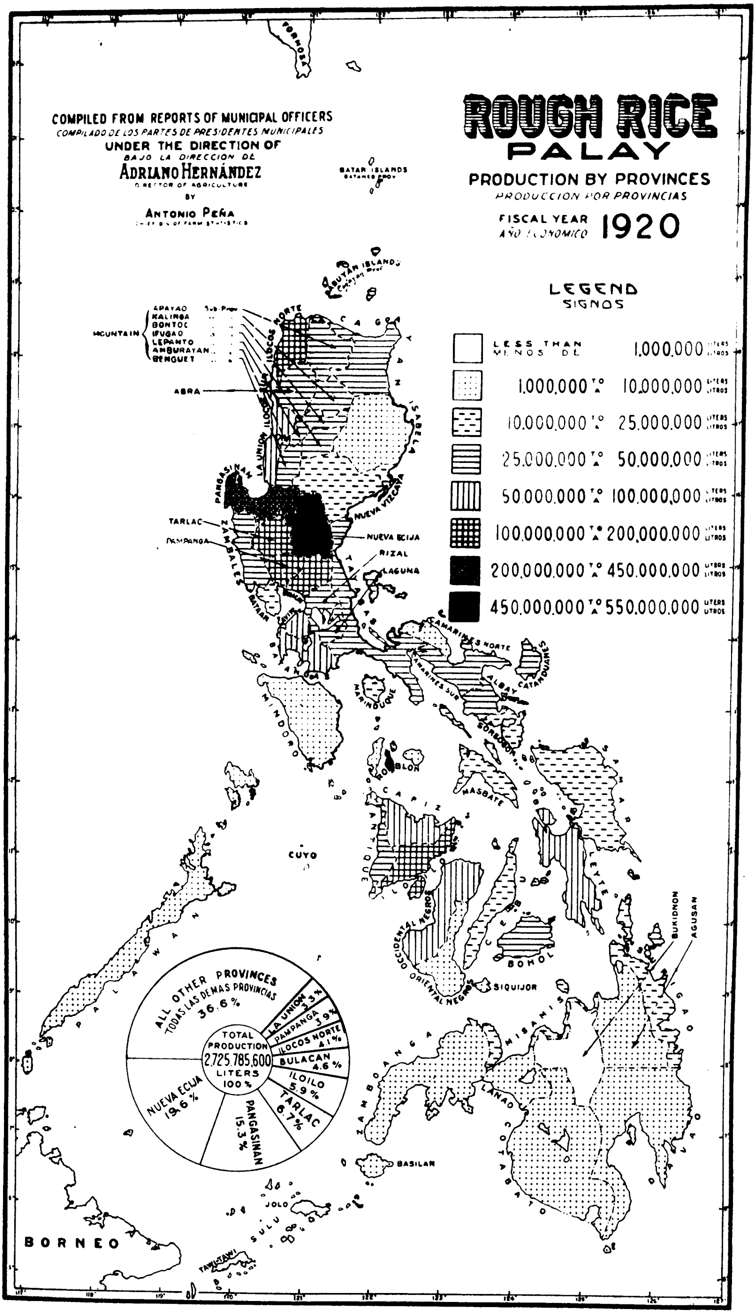
To them primarily the country looks for the solution of the rice problem, and so it seems timely to summarize what has been done in the eleven years that have passed since the Bureau of Agriculture began systematically to study rice culture.

The planting of selected varieties adapted each to a congenial locality, seed selection, the promising verieties the part water plays in the raising of rice, exact cultural methods as opposed to hit-or-miss attempts to raise a crop, an account of the experiments carried on, are the principal themes. The vastly important subject of machinery, particularly tractors, it is not as yet possible to speak of with any degree of authoritativeness as regards the Philippines, since the use of machinery is too new, the small farmers, who are in the majority, are too poor, and lowland rice is planted in the proportion of three to one as against upland.

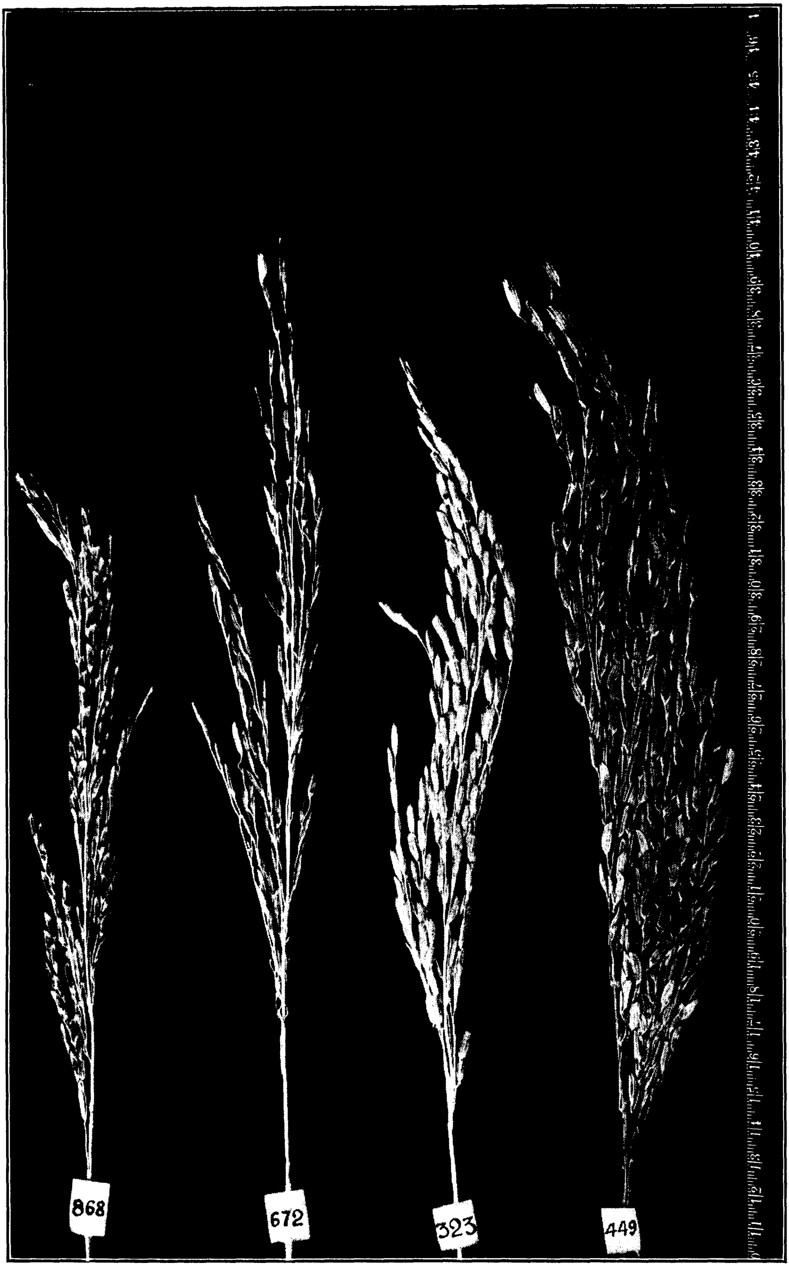
Furthermore, it not being as yet possible for us to establish the comprehensive system of irrigation our country needs and our legislature plans, here again little can be said.

All things considered, though, we believe this exposition will be of practical help to our farmers and serve as a guide to our young students of agriculture; and we hope it will not be without interest to others engaged, like this Bureau, in the task of increasing and improving the world's store of rice.

ADRIANO HERNANDEZ,
Director of Agriculture.



A Chart showing the relative production of rice in each province



Types of non-bearded lowland rice

Tinabas, Perm. No. 868
Pilapil II, Perm. No. 672
Kucong-uwak, Perm. No. 323
Inespaña, Perm. No. 449

RICE IN THE PHILIPPINES

By JOSE S. CAMUS, *Agronomist in Charge of the Agronomy Section*

INTRODUCTION

Rice, the plant that produces the main food—the staff of life, or, as one may call it, the bread—of the Filipino people, is the most important and most extensively cultivated crop of the Philippines. Indeed from time immemorial this cereal has been the principal food of all oriental countries, and its cultivation has constituted the chief occupation of most of the people. When Magellan discovered the Philippines in 1521, he found rice the only crop being cultivated by the natives. It is today the daily food of more than 60 per cent of the population of the world, and this per cent is constantly increasing, for it is now being more and more used by the people of the United States and European countries to supplement wheat flour, for the reason that it is found that under ordinary conditions it can be produced cheaper than any of the other cereals, especially if machinery is used. A combination of rice with legumes is a much cheaper balanced ration, too, than one of wheat and meat and it needs much less land to produce it.

The methods of culture followed at present in raising this cereal are rather primitive here, the single crop system being the most generally practiced, though in some provinces modern intensified farming is now in vogue and modern machinery and farm implements are more or less replacing the old crude implements all over the Philippines.

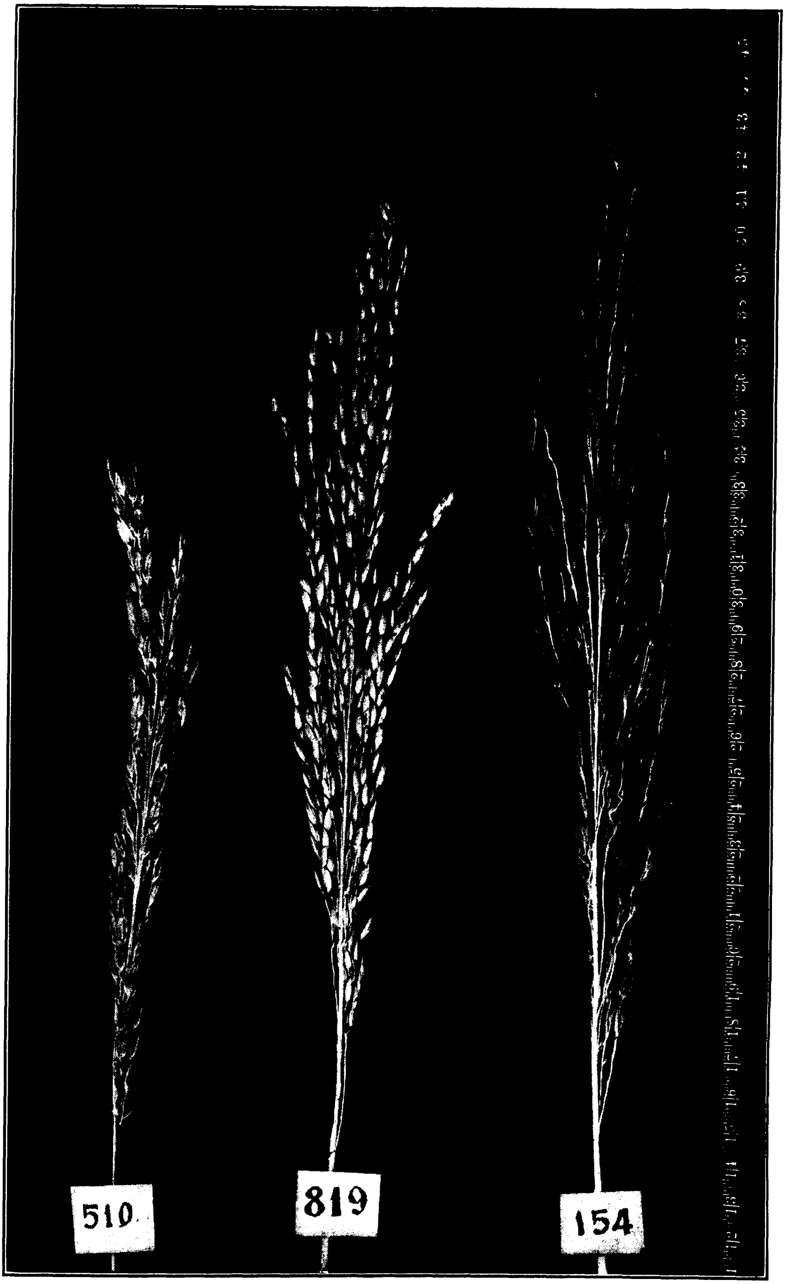
Due to the methods of culture and climatic conditions existing in these Islands rice was never grown here over large areas under one management, as in California and some of the Southern States, until lately, when the introduction of tractors has made it possible to plant rice on a big scale. But tractors can in most places only be used for upland rice. It is impossible to use them in planting our lowland palay except by following the method used in California; that is, the field is prepared dry and then the seed is drilled in, as in planting corn, and the whole field is flooded. This of course can only be done in places where irrigation water is available.

The tractor, however, has partly solved the labor problem arising from the high cost of wages and the scarcity of field hands. It makes possible the planting of a bigger area and in very much shorter time than by using animal power; it eliminates the factor of loss due to rinderpest and enables the farmer to use drilling and harvesting machinery. True, some modern machinery was tried here some years ago, and failed to give good results; but that was because it was drawn by carabaos and bulls while the speed of the machinery was rated according to a horse's walk, which is faster. At that time no tractors were available so that the heavy machines were found to be impracticable. It must be borne in mind, though, that the land used for rice in most places is not extensive enough and the fields are not properly laid out for modern agricultural implements, and the majority of fields are small, irregular strips of land divided from one another by levees or "pilapil" to form small paddies; so the present method of planting lowland rice is such that the use of heavy machines is inadvisable, as for these to be used successfully in these Islands the upland method of planting rice would have to be followed exclusively and all the levees destroyed.

VARIETIES

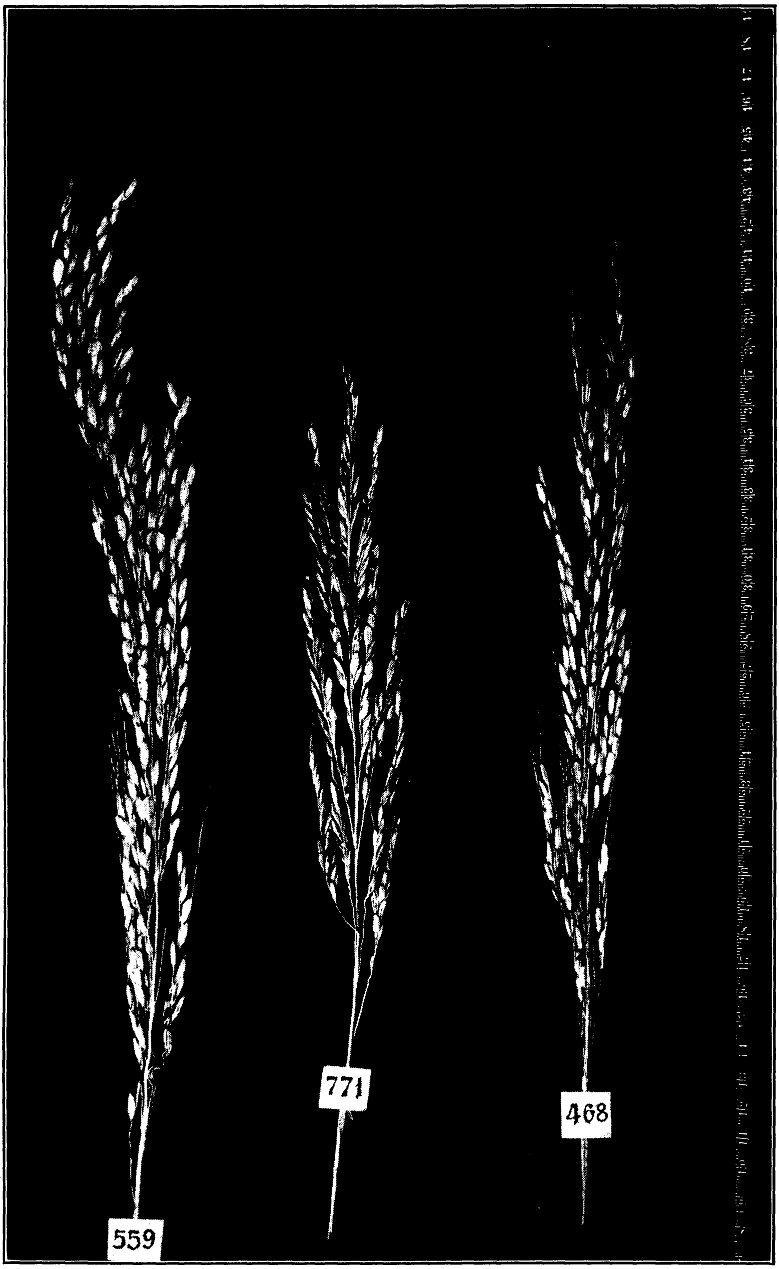
Rice (*Oryza sativa*) is an annual plant belonging to the great family of grasses botanically known as *Gramineæ*. The word *Oryza* is derived from the Asiatic word *Eruz* which was later modified into *rice, riz* and *reis*. It is believed to be indigenous to Asia, and is one of the plants that has a great wealth of varieties, all differing in the length of time they take to mature, and in character, yield, quality, size, shape, color of the grain, and even in the quality of the product and its flavor. There have been 1,282 varieties tested by the Bureau of Agriculture since 1909, but of these only 991 varieties have been found to be distinct varieties, the remainder being duplicates. A variety of rice is sometimes found under different names, the yield and characteristics having slightly varied due to environment; but when seed from these so-called different kinds are planted side by side in test plots and their characteristics compared, it will be seen that they came from plants of the same variety.

The great diversity in these many varieties is not easily comprehended but the large number of varieties is not surprising when we consider that as many as three thousand five hundred varieties are said to be growing in China, Japan and Siam, and remember that rice is one of the oldest plants grown in those countries and that since the middle of the last century there has not been constant intercourse between these countries and the



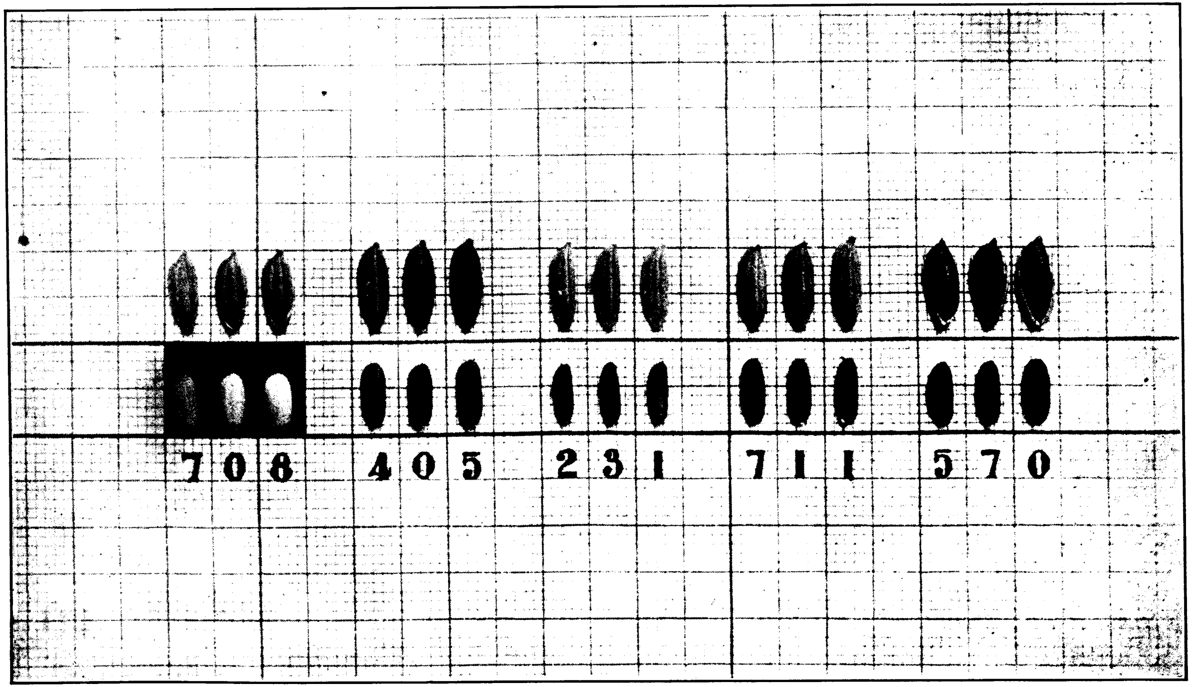
Types of non-bearded upland rice

Lirio, Perm. No. 510
Sinambauan II, Perm. No. 819
Cabatiñgan, Perm. No. 154



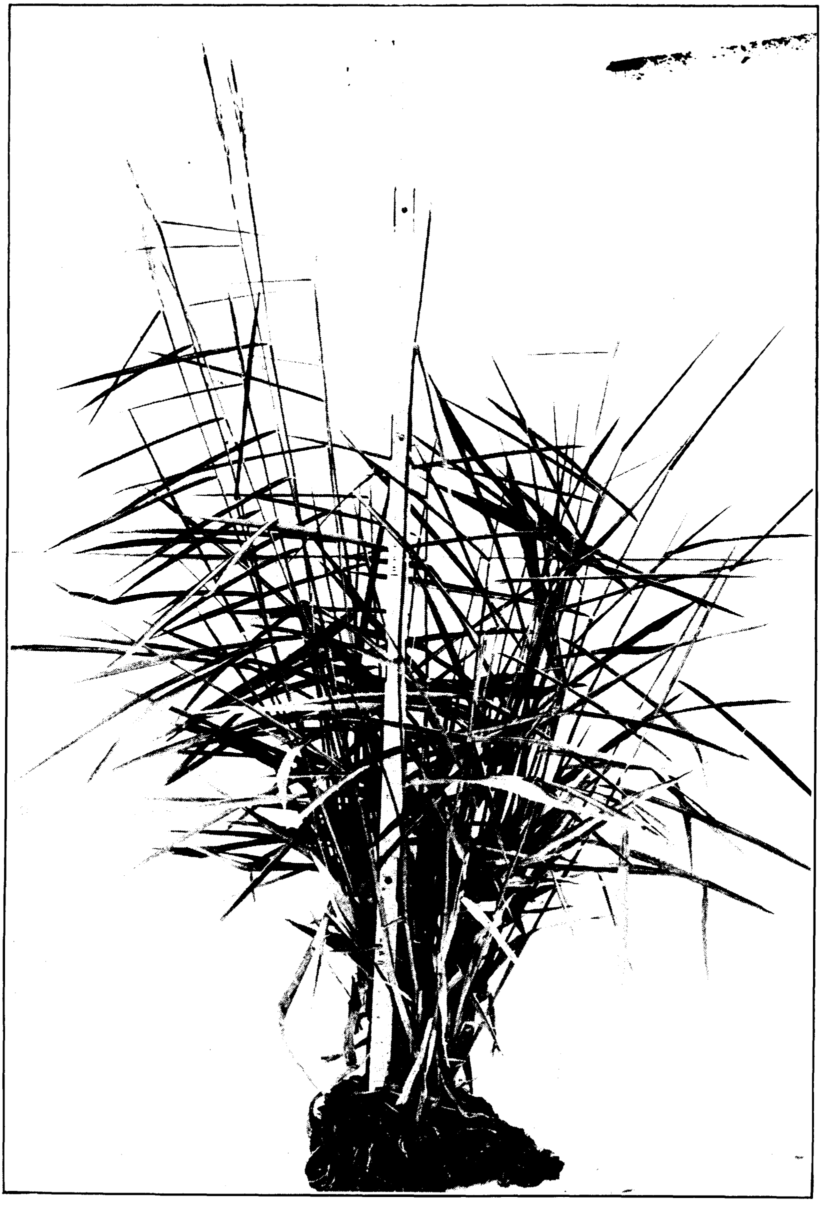
Types of bearded lowland rice

Malaca, Perm. No. 559
Reppeng, Perm. No. 771
Jasmin, Perm. No. 468



Types of glutinous rice

Portoc, Perm. No. 708; Guinaroan, Perm. No. 405; Calubad I. Perm. No. 231; Potan tandu, Perm. No. 711; Malagkit negro, Perm. No. 570



Philippine wild rice, *Oryza manilensis*

Philippines. This plant does not cross as easily as other plants, so it is hard to believe that the great number of varieties are really crosses. The writer believes that the cause of this great number is due to variations in character of soil, supply of water, and atmospheric conditions of the places where each variety has been grown.

All these have been classified into groups according to habitat or method of cultivation, into upland (non-transplanted) or lowland (transplanted) rice; bearded or non-bearded; and glutinous or non-glutinous kernels. The hulls as well as the kernels vary in color from semi-transparent white to deep purplish black. (See Plate III.)

The upland need comparatively little water for their development—in fact, too much water on the fields is often detrimental—and they thrive well without transplanting, while the lowland require plenty of water during their growth and have to be transplanted to obtain the best results. (See Plate IV.)

The bearded varieties are generally grown in the low-lying regions from northern Zambales, Tarlac, and Nueva Ecija up to Ilocos Norte. Only bearded palay can be planted in such regions as it can stand more being under water and for longer periods than non-bearded palay.

In countries producing rice on a commercial scale, like China, Japan, India, Cochin-China, United States, Spain, Italy, and other rice countries, the non-bearded rices are generally grown, although bearded varieties are also planted in Java at present. The yield of bearded rice is less than the non-bearded. The only advantages the bearded palay has are: It can be planted in low places where water stands for a long time; it is not susceptible to damage from birds on account of the awn; and can be easily handled and transported without the need of a container, as the grains do not fall so easily as those of the non-bearded varieties.

Bearded rices are, however, objectionable as in general they are poorer yielders and the crop is usually harvested head by head. It is difficult to thresh them even with a threshing machine unless this is provided with an awn-clipper to remove the beards, and unless labor is cheap and plenty there can be but little profit in raising them. (See Plate V.)

The glutinous includes those varieties having clear, transparent, hard kernels and the non-glutinous those having soft, chalky kernels. Some varieties are between these two and may be said to be crosses between the two groups—the grains are more or less cloudy or starchy. These are called semi-glutinous. Most of the Japanese commercial rices belong to this group.

The varieties Portoc, Perm. No. 708; Guinaroan, Perm. No. 405; Calubad I, Perm. No. 231; Potan tandu, Perm. No. 711; and Malagkit Negro, Perm. No. 570, as shown in Plate VI, are representatives of the glutinous rice. These cook up into a soft pasty mass, and are not used for general consumption but only for making special delicacies. Varieties of this group are called "Malagkit" by the Tagalogs, "Diquet" by the Ilocanos, and "Pilit" by the Visayan.

The varieties used for general consumption belong to the non-glutinous group. These are transparent, and hard and when cooked in the native way the kernel retains its form, but is easily squashed. Though called non-glutinous, there is enough glutinous matter, however, to hold the mass together when boiled. Filipinos generally like to eat rice boiled hard but the Chinese prefer rice boiled soft with much water. Some of the best varieties that belong to this group are shown in Plates XXXVI and XXXVII.

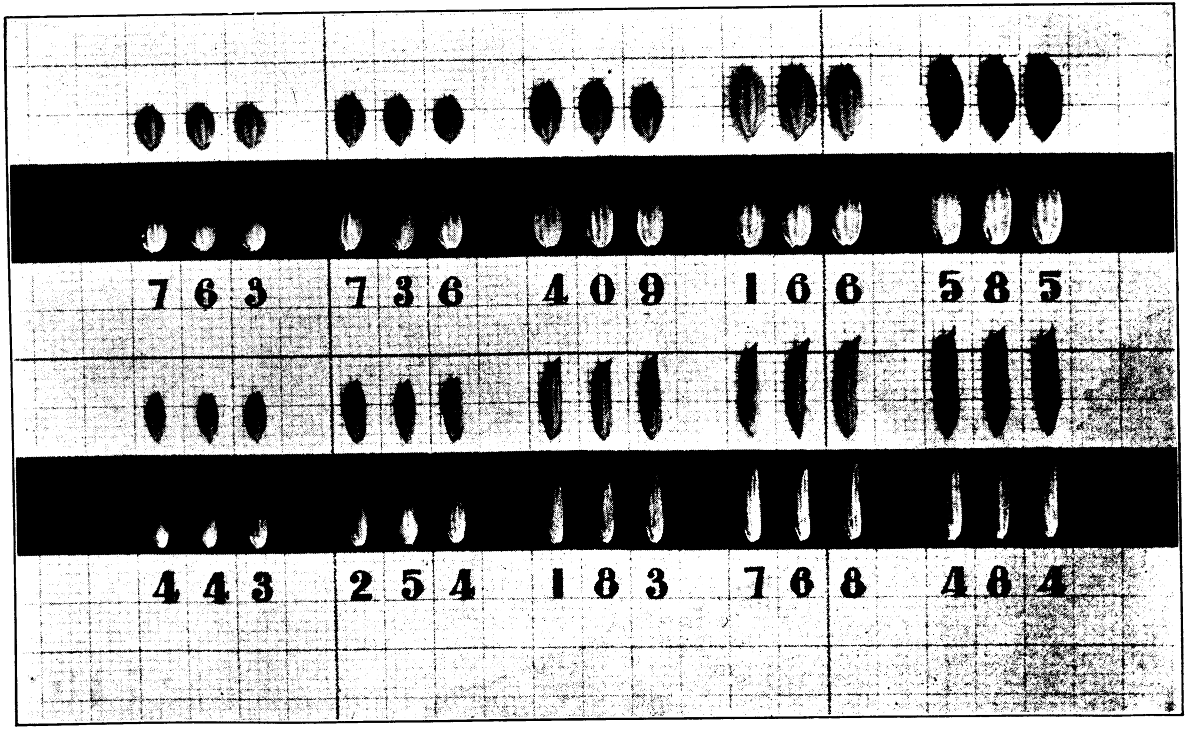
There are some varieties that are prized for their special flavor, which is most pronounced just after harvest, as the varieties Capino I, Perm. No. 257; Inantipolo II, Perm. No. 956; Mimis I, Perm. No. 616 and Binicol I, Perm. No. 92.

A new species of rice known as *Oryza manilensis,* found growing wild in Gubat, Sorsogon, is shown in Plate VII. Some seed of this was collected by the Bureau of Agriculture in 1914 and planted at Alabang, Rizal, to find out if it had any economic importance. It differs from the ordinary rice plants in growing rather slowly and attaining no great height; it stools heavily and produces panicles at irregular intervals which do not mature uniformly. The kernels, which are very small, mature in from 80 to 90 days after planting and drop off as they ripen, so this rice is of no value for human food but planted either broadcast or transplanted it might produce a forage crop.

TYPES OF GRAINS

The commercial varieties of rice in the Philippines are generally 2.5 millimeters wide by 5.5 millimeters long, but there is quite a difference in shapes. The broad type will vary in size from 2.5 by 2.5 millimeters to 3 by 8. Japanese rice are generally of this type. The slender type varies from 2 by 4 millimeters to 2.5 by 9. The varieties Quinulantro, Perm. No. 763 and Mandogosoc, Perm. No. 585 are examples of the first type and Inanis, Perm. No. 443 and Kinanay, Perm. No. 484, are examples of the second. (See Plate VIII.)

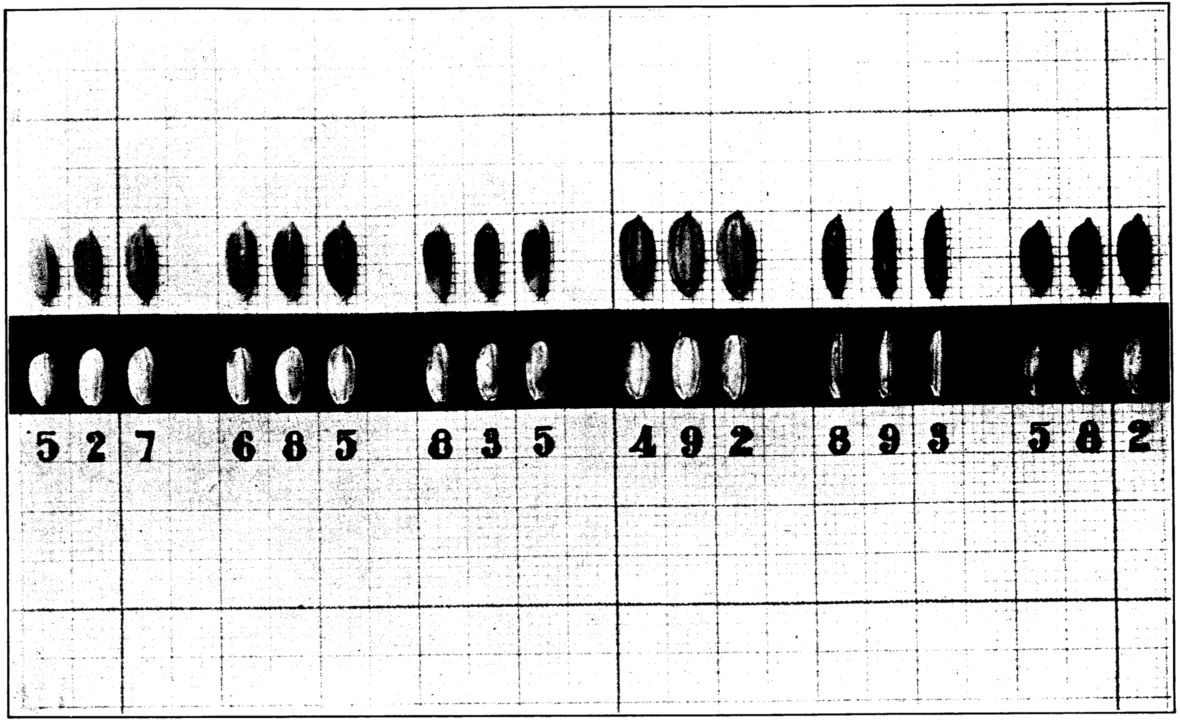
Varieties having grains three or four times as long as wide are the ones generally eaten by the rich people. These gen-



Showing variation in shape and size of rice grains

Quinulantro, Perm. No. 763; Quinamalig, Perm. No. 736; Gui-os I, Perm. No. 409; Cabonog, Perm. No. 166; Mandogosoc, Perm. No. 585; Inanis, Perm. No. 443; Capichola, Perm. No. 254; Cadimaya, Perm. No. 183 ; Romero I, Perm. No. 768; Kinanay, Perm. No. 484

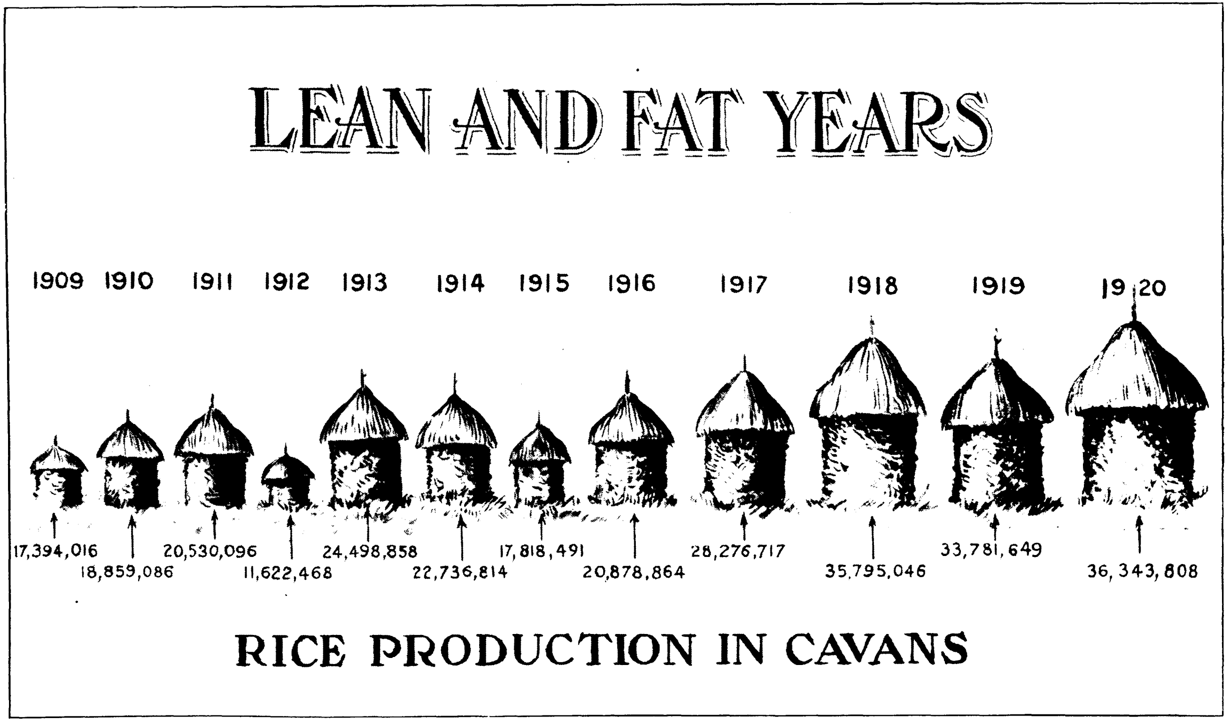
PLATE IX



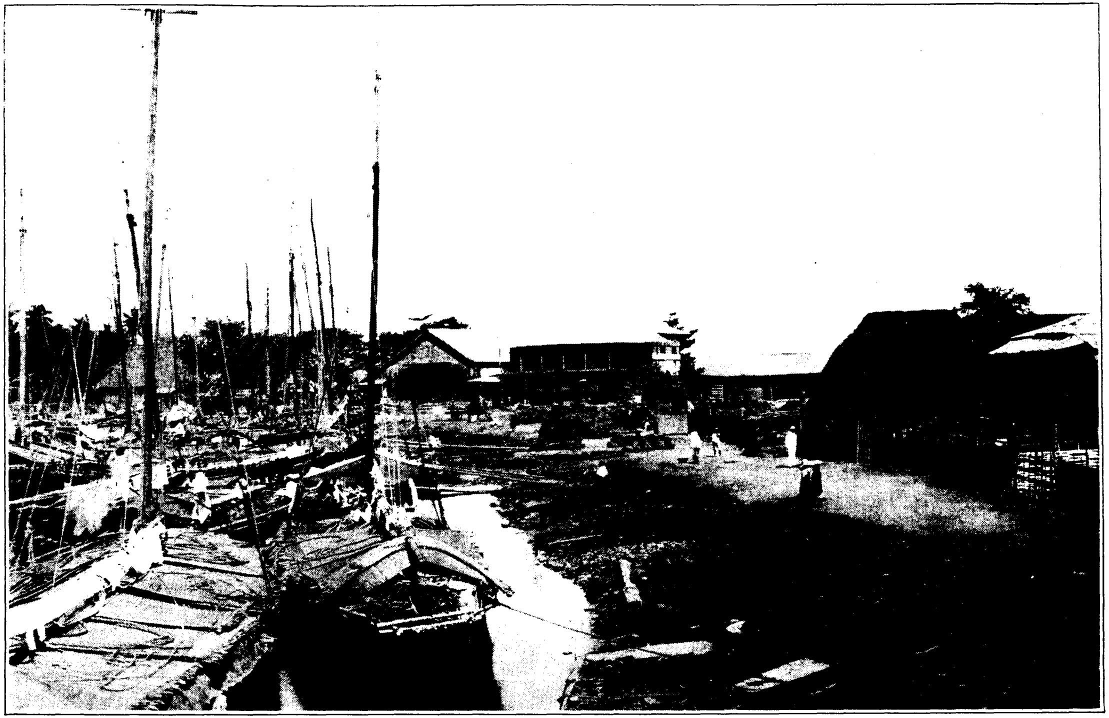
Showing variation in color of unhulled rice

No. 527, straw colored; 685, brown body, light stripes; 835, dark body, straw base and tips; 492, straw body, purple stripes and tips; 893, dark purple; 582, reddish brown

Macan I, Perm. No. 527; Pinalilan, Perm. No. 685; Sota, Perm. No. 835; Kumaguinquing, Perm. No. 492; Ulian, Perm. No. 898; Manay, Perm. No. 582



Graphical comparison of the annual production of rice for the last twelve years



Riverside view in Dagupan, Pangasinan, where bearded palay is marketed. The big piles are made of palay in heads erally have a good flavor but are poor yielders. When cooked and put on the table they look particularly appetizing. A good example of these varieties is the "Mimis I," Perm. No. 616. The grains are so long that when milled they break into pieces, hence the variety is undesirable to grow on a large scale. The varieties Binicol I and Inantipolo II are also noted for their exceptionally good flavor.

In color the grains range from clear transparent to solid white, and from slightly red to almost black. The red rice, or those having dark-colored cuticle, are more nutritious than the white ones, as they are dark in color because the outer coating, which contains the phosphorus of the kernel, has not been rubbed off, as with those cleaned in a rice mill. Rice prepared in wooden mortars is a better food due to the above reasons and because it still contains some of the bran and germ, which make it more nutritious than milled rice. Some prefer its flavor, also, just as some people prefer yellow corn meal to white.

COLOR OF HULL

The prevailing color of the hull is light straw or golden, but there is almost every variation in color between straw and dark brown, chocolate or black. Many have a dark body with light tips or vice versa; still others may be striped. (See Plate IX.)

STATISTICS

Of the total area of the Philippines, which is about 120,000 square miles (29,629,000 hectares), about one-third is virgin forest; one-eighth is second growth forest; two-fifths is grassland good for agricultural purposes, and only about one-tenth is under cultivation at present. It is reported that up to June 30, 1920, the area cultivated to rice was only 1,484,895 hectares, and the production 1,584,154 metric tons (36,343,808 cavans) of rough rice (palay).

The total area planted to this cereal in 1920 is about the same as that planted to abaca, coconut, corn, sugar cane, and tobacco put together. The total production was valued at ₱254,855,385, or about 59 per cent of the combined values (₱432,276,117) of these five crops. Counting the population of the Philippine Islands at 10,350,640 (1918 Census), there were about three and one-half cavans of rough rice produced per capita.

The following table shows the area cultivated, total production, value, average yield per hectare and the total importation of rice:

TABLE NO. 1

Years ending June 30—	Area cultivated in hectares	Total production of rough rice (palay)			Average yield per hectare in cavans	Total importation of clean rice (arroz)	
		Kilos	Cavans	Value		Cavans	Value
1909	1,156,105	747,942,688	17,394,016	₱52,355,988	15.05	2,394,393	₱8,500,446
1910	1,192,141	810,940,698	18,859,086	55,765,849	15.82	3,210,781	10,643,924
1911	1,043,757	882,794,128	20,530,096	61,795,589	19.67	3,531,873	13,121,260
1912	1,078,891	499,766,124	11,622,468	39,981,288	10.77	4,526,081	21,139,898
1913	1,141,242	1,053,450,894	24,498,858	57,939,799	21.47	3,116,607	15,881,714
1914	1,244,937	977,683,002	22,736,814	57,261,760	18.26	1,422,400	5,601,678
1915	1,130,713	766,195,113	17,818,491	49,207,978	15.75	3,052,889	10,896,602
1916	1,140,829	897,791,152	20,878,864	55,923,821	18.30	3,182,891	11,694,389
1917	1,225,692	1,215,898,831	28,276,717	81,377,812	23.07	3,128,913	12,941,817
1918	1,368,140	1,539,186,978	35,795,046	135,163,375	26.16	2,767,487	12,334,030
1919	1,381,339	1,452,610,907	33,781,649	188,614,588	24.45	2,586,509	16,977,180
1920	1,484,895	1,584,154,028	36,343,808	254,855,385	24.48	191,619	2,782,244

It will be noted from the above table that about one-sixth of the rice consumed is imported. The biggest importation ever made during the last ten years was in 1912 when there was a prolonged drought. The area planted to rice last year (1919 crop) exceeded that of any previous years, but in spite of this a big amount of rice was imported due to the floods in September (1919) which damaged the principal rice producing regions. (See Plate X.)

About thirty years ago there was a surplus production of rice so that this cereal entered into the list of exports of these Islands, but since that time yearly importations have been necessary to meet the demand. The reason for this is that many of the people who before raised rice are now planting other crops, such as sugar cane, coconuts, hemp, etc., instead, while others have left the agricultural profession entirely and gone into the towns and cities. Another highly important reason for this has been the loss of work animals during epidemics. But the scarcity will be less important very soon when a greater number of farmers use tractors.

Estimating that each of the inhabitants of the Philippines consumes an average of two and a half cavans of rice per year, then for 10,350,640 people, of whom about 80% only eat rice, only 41,402,560 cavans of palay will be needed to supply the demand. The total production for the fiscal year June 30, 1919 to June 30, 1920 was 36,343,808 cavans, so that it would be necessary to produce 5,058,752 cavans of palay or about 2,529,376 cavans clean rice more in order to supply the need and make the importation of rice unnecessary. This shortage, however, could easily be turned into a surplus by the use of selected seed and proper methods of planting even without increasing the area.

Table No. 2 gives a detailed statement of the yield by prov-

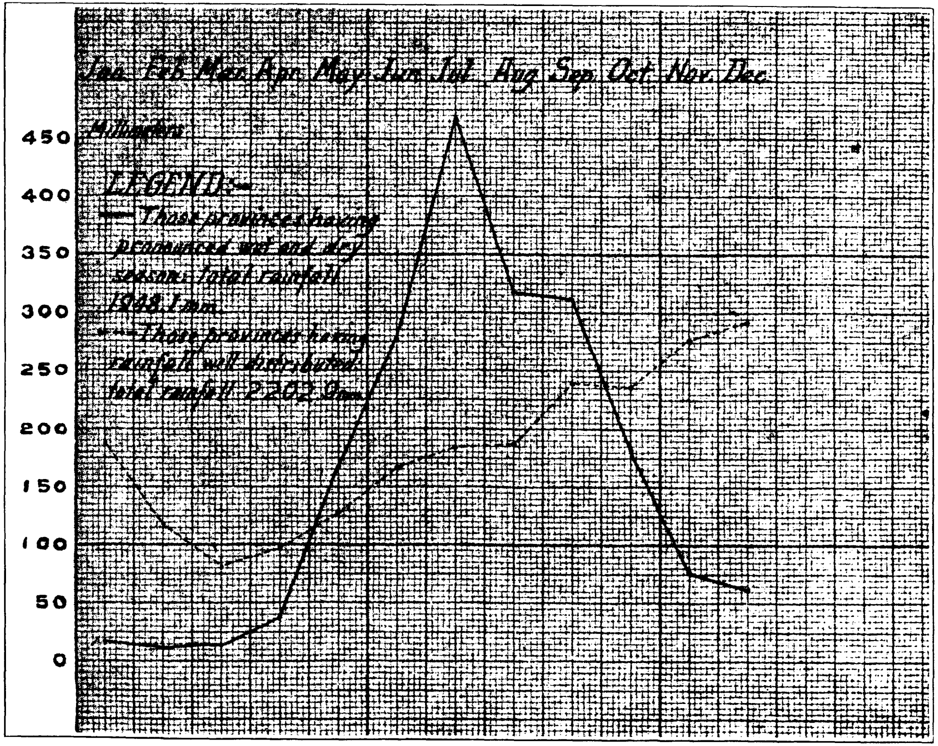
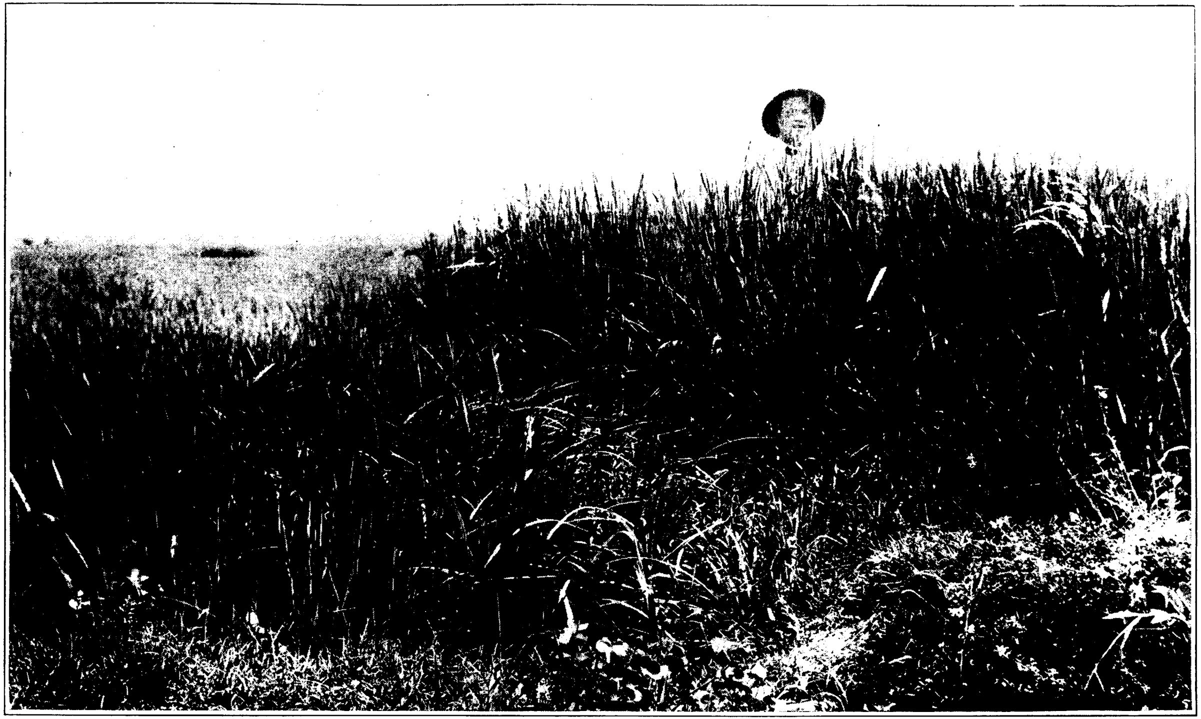


Chart showing the average rainfall

PLATE XIII



Conner, a medium-early variety, and Macan I, a late variety, planted in 1916 side by side in the rice demonstration plat in Rosario, Cavite inces. The rank of the heavy yielding provinces, as shown in the first column, remains fairly constant from year to year.

Rice farming in the Philippines is not a stable industry, as the production varies according to the demand for labor in other directions generally. For example, when the price of sugar or some other crops goes up a greater area is planted to same and consequently there will be a demand of labor on that particular crop. Rice is a crop which has a constant price in comparison with abaca, coconuts, and sugar cane but less people plant it when the area of other crops is increased, due to the higher wages paid for planting other crops in greater demand. The establishment of factories in cities and big towns has also reduced the number of rice planters and therefore reduced the rice production.

TABLE NO. 2

ROUGH RICE (PALAY)

Crop statistics for the Philippine Islands year ending June 30, 1920.

Rank	Provinces	Area cultivated	Production	Average production per hectare	Average price per cavan	Total value
		Hectares	*Cavans*	*Cavans*		
24	Abra	16,217	392,915	24.23	₱7.83	₱3,075,599
43	Agusan	2,499	43,068	17.23	6.51	280,309
18	Albay	29,003	578,012	19.93	7.68	4,436,502
17	Antique	31,524	594,458	18.86	5.36	3,188,921
28	Bataan	9,157	276,612	30.21	7.08	1,959,148
46	Batanes	64	714	11.16	7.43	5,304
14	Batangas	37,500	670,139	17.87	8.32	5,575,531
22	Bohol	35,904	499,853	13.92	7.14	3,570,040
45	Bukidnon	1,020	11,828	11.60	4.64	54,864
5	Bulacan	59,867	1,660,150	27.73	7.06	11,718,468
19	Cagayan	25,206	555,751	22.05	7.42	4,124,940
37	Camarines Norte	4,850	75,224	15.51	6.99	525,614
15	Camarines Sur	33,143	634,743	19.15	7.14	4,531,526
10	Capiz	44,831	941,719	21.01	6.14	5,786,550
11	Cavite	36,494	867,068	23.76	7.67	6,652,687
33	Cebu	7,290	134,971	18.51	7.51	1,013,781
44	Cotobato	1,864	29,557	15.86	5.10	150,371
40	Davao	4,319	58,683	13.59	6.17	362,149
6	Ilocos Norte	74,059	1,479,671	19.98	7.13	10,552,879
9	Ilocos Sur	45,235	950,549	21.01	8.29	7,882,528
4	Iloilo	121,630	2,136,150	17.56	7.82	16,699,626
39	Isabela	3,073	69,431	22.59	13.14	912,561
16	Laguna	23,476	629,213	26.80	7.29	4,585,459
41	Lanao	3,661	57,965	15.83	7.22	418,320
8	La Union	50,930	1,210,660	23.77	8.03	9,721,508
12	Leyte	38,435	833,668	21.69	7.88	6,573,043
29	Marinduque	14,974	215,181	14.37	7.43	1,599,358
34	Mindoro	5,665	128,088	22.61	5.42	694,075
30	Misamis	8,354	192,988	23.10	5.86	1,130,446
25	Mountain	26,344	378,648	14.37	7.48	2,831,458
1	Nueva Ecija	162,471	7,136,395	43.92	6.35	45,320,978
32	Nueva Vizcaya	6,317	175,658	27.81	4.92	863,621
13	Occidental Negros	41,628	702,399	16.87	7.40	5,196,405
36	Oriental Negros	4,952	100,034	20.20	5.04	504,131
42	Palawan	3,249	52,430	16.14	5.44	285,108
7	Pampanga	65,568	1,408,488	21.48	7.12	10,035,457
2	Pangasinan	179,393	5,556,898	30.98	6.87	38,162,189
21	Rizal	25,310	531,522	21.00	7.11	3,779,151
35	Romblon	6,786	103,295	15.22	7.46	770,935
27	Samar	15,711	295,289	18.80	7.27	2,147,755
31	Sorsogon	13,318	186,365	13.99	8.06	1,502,406
47	Sulu	833	10,000	12.00	6.03	60,300
26	Surigao	16,664	316,762	19.01	9.49	3,007,359
3	Tarlac	87,772	2,437,293	27.77	6.33	15,437,924
20	Tayabas	29,995	538,417	17.95	7.27	3,912,482
23	Zambales	23,373	413,840	17.71	6.90	2,857,467
38	Zamboanga	4,967	71,046	14.30	5.61	398,267
	PHILIPPINE ISLANDS	1,484,895	36,343,808	24.48	7.10	254,855,385

UNIT OF MEASURES USED IN RICE PROVINCES

Most of the provinces producing rice measure it by the cavan, the average weight of which is 44 kilos for rough rice (palay with sack), and 57.5 kilos for clean rice per cavan of 75 liters. A cavan of palay including the sack may weigh more or less than 44 kilos, depending upon the variety of rice. Bearded palay or the varieties generally grown in the northern provinces is measured in bundles of some standard size known as "manojos," or "pungos," as this cannot be measured by the cavan for the beards interfere with the packing of the grains in the measure. An average manojo weighs about 10 kilos. The size of these bundles or manojos varies in each province. Each manojo, or as sometimes called "pompon," consists of six small bundles, about 7 centimeters in diameter, known as "manojitos," "quinis," or "bulsác." This number varies in different places even in the same province. Twenty manojos make one "oyón," which is approximately two and a half cavans of clean rice. Most of the rice mills in northern Luzon now measure it by weight. Plate XI shows the palay market in Dagupan, Pangasinan, where mostly bearded palay is sold.

SOIL

It is impossible to describe the type or to say just what soil is most suitable for the cultivation of rice. The plants can be grown on any kind of land but best results from lowland varieties are obtained from fairly rich loamy clay soil with a layer of impervious clay or with a hard subsoil beneath.

In general, a soil that will produce good corn, sugar cane or camote will also produce good rice, especially the upland varieties, but it does not follow, however, that good rice land will always produce any one of the above crops, as generally good lowland rice land is too heavy and has an impermeable subsoil, which condition is detrimental to other plants as it accumulates too much water for a certain length of time. Light sandy soils do not hold water so that they are not adaptable to rice planting.

This impervious layer is an important requisite for transplanted or lowland rice, as it helps to retain water and food materials and to make possible a continuous submergence of the land for a period of time, which condition is required for the best development of the plants.

Lowland rice does not need very deep soil, in fact a fairly shallow soil is preferable to a deep one, as the cost of submergence and the time required in irrigating and the amount of water depends upon the depth of the soil. When the amount of water used is to be paid for, this point becomes particularly important.

As level land as possible should be selected since the cost of preparation and getting water to the land and distributing it is much less. Another advantage of this is that where the land is level big paddies can be built, the number of dikes reduced, some of the expenses incurred in their construction saved, loss and inconvenience in the operation of the field lessened, the space occupied by the dikes economized and less breeding places for weeds and plant pests left. If the paddies are sufficiently large, as the rice fields in California, tractors and other farm machinery can be used in the cultivation of this crop.

The condition of the land is also important in rice growing, as level land is also necessary to give the crop a uniform ripening. The presence or absence of water in the field due to the contour thereof, influences to a great extent the uniformity of ripening. Very often a section of the field can be seen where even if only one variety is grown and it has all been planted at the same time, the crop is ripe enough to be harvested in one place, while the rest of the field is still green, and vice versa. This is due to unevenness of the field, there being deep places where water accumulates and the plants grow taller and take a longer time to mature, while those planted on the hills mature earlier. In these cases the crop is harvested even if all the grains are not yet fully ripe. Palay harvested this way produces a low grade rice when milled.

The lowland varieties are semi-aquatic in nature, as they prefer heavy clay soils containing about 20 per cent of fine silt and about 45 per cent of clay that can be puddled thoroughly. Land that can be effectively drained should be selected as it dries out and hardens readily so it can be walked on at harvest time much sooner than lighter soils. Those too rich in nitrogen are not desirable, as they cause the plant to produce too little grain and too many leaves and stalks. Such plants are easily beaten down by high winds and heavy rains and should therefore have their tops cut off to prevent them from lodging. Nitrogenous soils give better returns when planted to corn and sugar cane, provided there is good drainage.

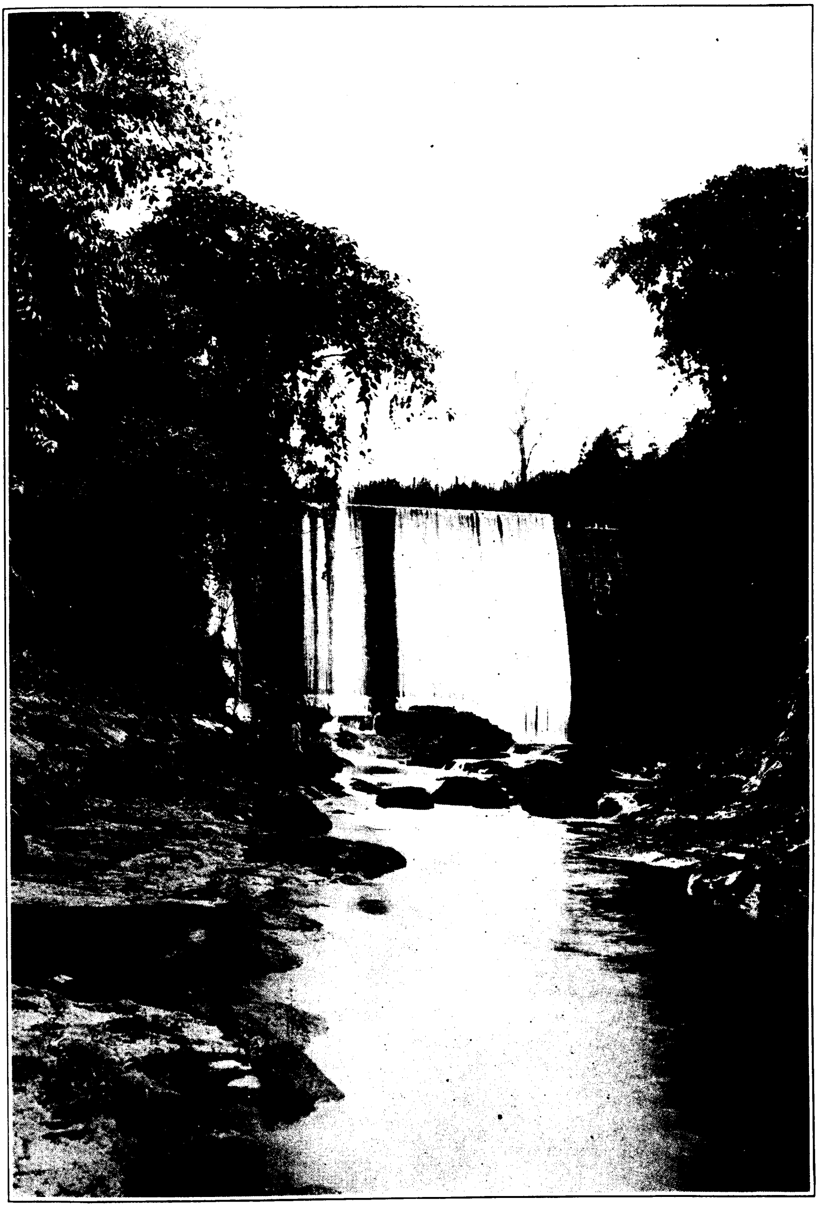
In the best rice producing provinces, such as Nueva Ecija, Pangasinan, Tarlac, Bulacan et al, most of the soil consists of a heavy clay containing about 20 per cent fine silt (0.01 to 0.002 millimeter in diameter) and 40 per cent clay (less than 0.002 millimeter) and a sufficient amount of humus.

Upland rice when grown on heavy clay soil gives poor results. It requires loamy soils—those that have been washed down from higher levels and which are usually richer in plant food. Soils in the valley and those of newly opened up lands give high yields when planted to upland rice. However, soils too rich in nitrogen are not adapted to upland rice either.

CLIMATE

Provinces producing rice as their main crop may be divided into two groups: those that have a pronounced wet and dry season, and those that have their rainfall distributed more or less throughout the year. Most of those having pronounced wet and dry seasons are located in Central Luzon, and those having a well distributed rainfall are near the Pacific coast or towards the southeast, where a two-crop system is practiced. The difference in rainfall is due to the direction the monsoons blow from and the trend of the mountain ranges. The first group includes the provinces of Bataan, Bulacan, Batangas, Cavite, Iloilo, Ilocos Norte, Ilocos Sur, Laguna, Nueva Ecija, Pampanga, Pangasinan, Rizal, Tarlac, La Union, etc. The second group includes Albay, Camarines Norte and Sur, Leyte, Samar, Sorsogon, and Tayabas. At present the great majority of rice producers depend upon the rains for irrigating their crops, except in a few places such as Cavite, part of Laguna, Pampanga, Bulacan, Tarlac and some other provinces which have irrigation systems. As previously stated, only one crop of rice is generally planted, especially in those places without irrigation and this is done at the beginning of the rainy season. The rainfall for these two groups is expressed by the rainfall curves shown on Plate XII.

The average rainfall for the rice-growing months in the most important provinces is as follows: May 239.7; June 295.8; July 1,427.1; August 1,530.9; September 836.75; and October 259.5 millimeters. It is in such localities that irrigation plays a great part in rice growing, for two reasons: First, because rice can be planted at the proper time for its best development; and second, two crops may be grown each season, thus increasing the amount that can be produced each year at least one-third. Where two crops are grown, the planting should be carefully timed so that the growing crops will not be damaged by the excessive heat; for example, if an early variety is used for the rainy season crop and is transplanted by June 10, it can be harvested by October 1 and the second crop transplanted by October 31, and by planting another medium early variety, another yield can be obtained and the crop be out of the way by January 22. Experience has shown that rice planted in the months of February or March, even though given plenty of water, is retarded by the excessive heat and evaporation. Rice plants need a rather humid atmosphere



An old irrigation dam built by the friars in Calamba, Laguna

Rice grown under irrigation, Alabang Central Rice Breeding Station for their best development, even though provided with an adequate supply of irrigation.

The rainy season in the Philippines is so often irregular in starting and stopping that it cannot be depended upon. Sometimes, even, it is dry a whole month in the so-called rainy season, which does great damage to the rice crop.

THE IMPORTANCE OF WATER

The duty of water in the cultivation of rice cannot be overemphasized. The lowland varieties, being semi-aquatic in nature, an adequate and constant supply of water during the entire development of the plant is needed, while the upland varieties, however, as before stated, need only a very little amount of water, so that what they can get from the rains is enough for their proper development, as long as they are planted in the proper time, unless there is a drought.

It takes about 110 to 115 hectare-centimeters of water to grow a normal rice crop, provided it is evenly distributed over the growing season. The amount necessary also, to some extent, depends upon the physical character of the soil and length of maturity of the variety planted. The longer it takes a variety to mature the more water it will need. So that how to gauge the amount of water to be used is one of the important problems of rice planters. Some varieties, generally the early-maturing, are hardier than others; they can stand a drought as they need less water. Certain others, especially the late-maturing, can only be made to stool and bear with a liberal supply of water. As a general rule, however, it can be said that it is more harmful for lowland rice to have too little water than too much.

Rice seedlings should not be watered until the seventh day after transplanting unless there is a drought which makes the soil too dry for the newly transplanted seedlings, and then the paddies should be watered about four to six inches deep until that period of the plant known as the "milk stage" is passed. It is sometimes good to drain off the water entirely to expose the base of the plants to the direct action of the sun and allow the soil to warm up and become aërated. In this case care should be taken not to dry up the field too long, for if the ground becomes air-dried the young growing seedlings will suffer seriously. And once the plants are checked they do not recover very well. A proper supply of water helps, to a great measure, in keeping the weeds down. This is why weeds do not trouble the rice producers here in the Philippines as in the States.

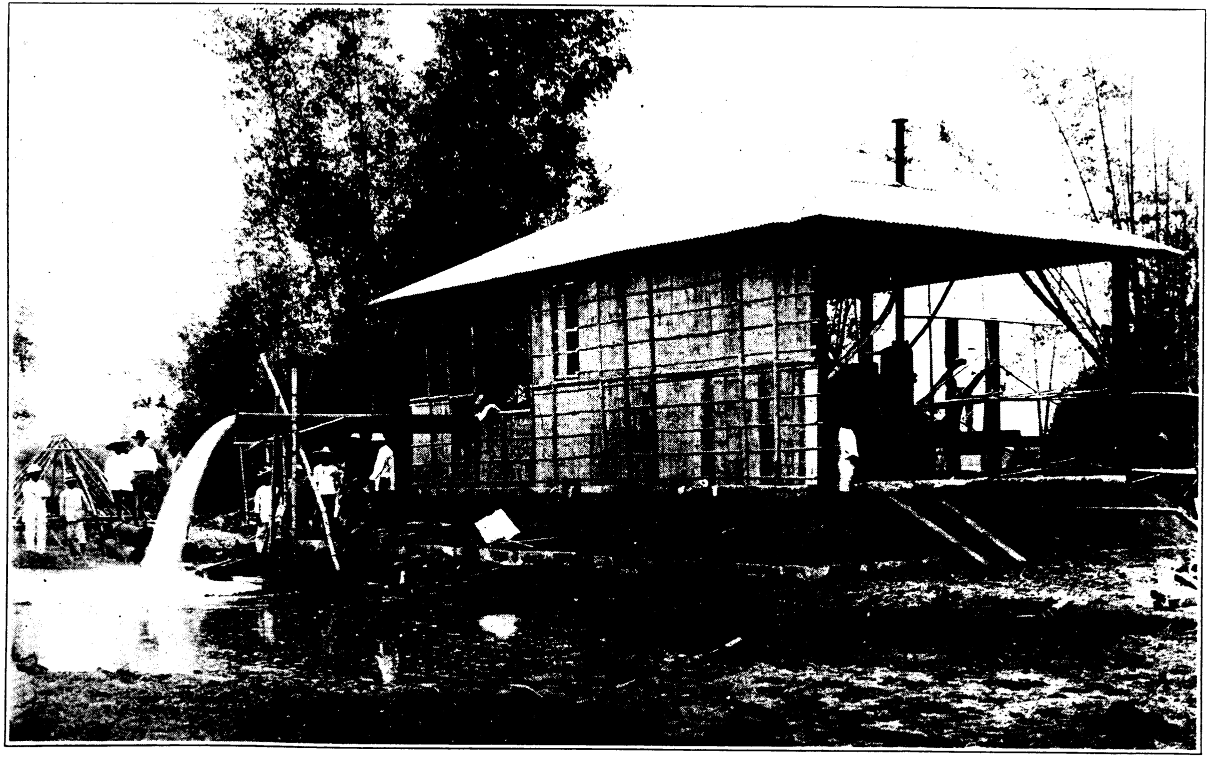
Crop failures, in many cases, are the results of poor management. By poor management is meant the planting out of season—either too early or too late—poor preparation of the land, etc. There are also cases when the seedlings are allowed to remain in the seedbed too long. Sometimes farmers are too lazy to fix the dikes or to level their fields, which results in an unequal distribution of water among the paddies.

In order to take advantage of the proper season, especially if there is no irrigation water, planting should be begun as soon as practicable, all dikes properly fixed and some early-maturing varieties planted. (See Plate XIII.) In provinces without irrigation systems it is not safe to plant varieties maturing in over 150 days from seeding. It is important that seedlings should be transplanted at the right age. Actual experiments have shown that, within a certain limit, the maturing age varies in direct ratio to the age at which the seedlings are transplanted. In other words, the older the seedlings are when transplanted, the later the crop matures.

It has also been observed that water from lakes, large rivers or canals with a low current is better than that from rivers having a swift current, for the water generally contains more fertilizing materials.

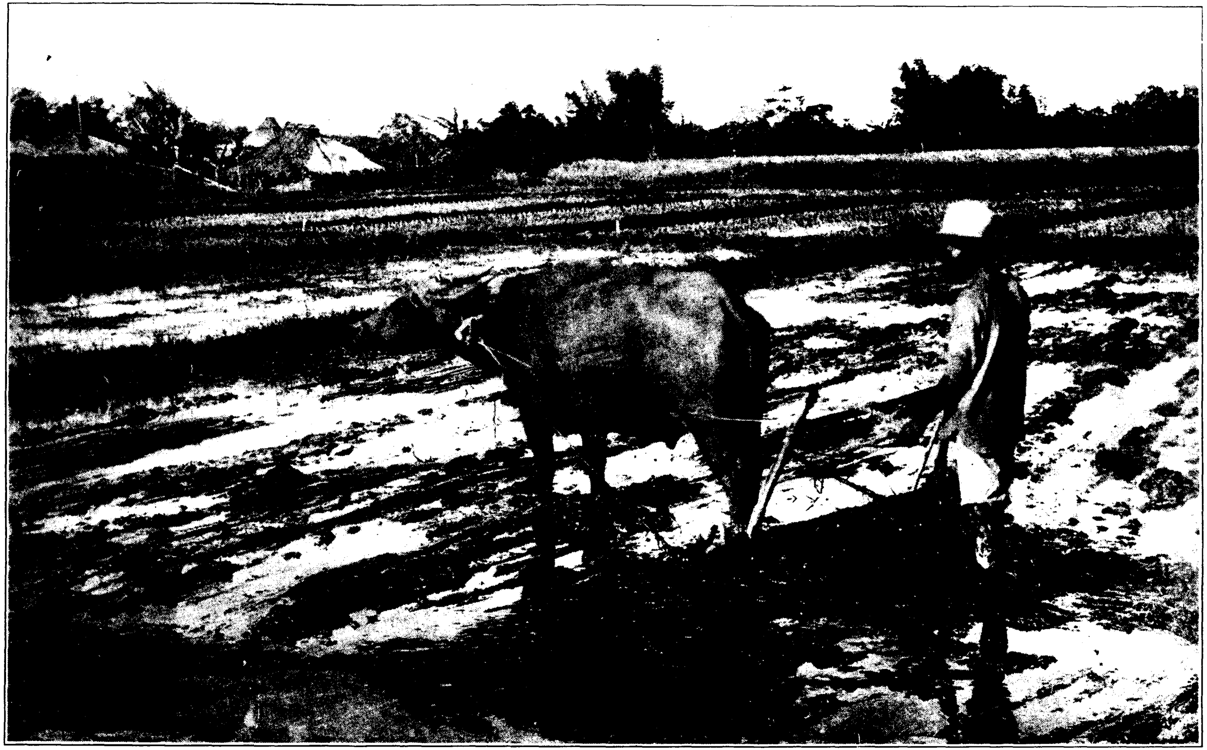
IRRIGATION

Irrigation is the permanent solution of the problem of preventing rice shortages, as this will guarantee a sure crop every year, even if there is a drought, and furthermore irrigation will make possible the raising of two crops a year. At present only a very small percentage of the total area of the Philippine Islands is provided with irrigation systems. Some of these systems were lately built by private parties and commercial firms but the majority of them were constructed about forty years ago. One of them is shown in Plate XIV. According to the Bureau of Public Works only about 50,587 hectares of land were under irrigation in 1912. No available data can be had on the total area of land under irrigation at present. Many of the irrigation systems are large but antiquated; others are small and consist of only a diversion dam made of brush and earth which is washed away with every flood. According to a survey made in 1920 by the Bureau of Public Works at least 559,000 hectares could be easily brought under irrigation. Very active interest is being taken by said Bureau in constructing irrigation systems in all places that are in need of them so that within a very few years it is hoped that most of the areas unirrigated which are at present lying idle will be under irrigation and thus will produce good crops of rice. (See Plate XV.)



Pumping plant for irrigating rice fields in Cainta, Rizal

PLATE XVII



Puddling rice field with a native harrow called "suyod"

PUMPS

A large part of the Philippines is high, rolling land called "terreno alto" or "secano." This land cannot be irrigated by the gravity system but can be watered by means of pumps. In the States a large number of farms are irrigated by pumping water from shallow streams or wells. The same method can be used in the Philippines very economically, provided the total lift is not more than nine meters. There are several pumps in the market that may be used for this purpose but a direct-connected centrifugal pump is recommended by the writer on account of its simplicity of construction, durability, cheapness, and the small danger of its getting out of order. (See Plate XVI.)

As previously stated, about 112 hectare-centimeters, or 44.8 inches of water, when well distributed in about one hundred days, is sufficient to mature the average 150-day varieties of rice on stiff clay soils. If the soil, however, is sandy the loss from seepage is great. In this case allowance should be made to cover the loss.

Upland palay needs a very little amount of water; generally what can be obtained from the rainfall is enough to mature the crop. In the Philippines a less amount of water than what is used at present should be applied to rice as there is a waste of water in rice fields. The practice of letting the water flow from paddy to paddy can be followed and at the same time only a small amount of water used, if instead of the water being let run down the canals, it is allowed to flow from paddy to paddy. In this way there will be only a little loss of water. The proper care of dikes to prevent leakage is also an essential factor in economizing water.

To give an idea of the cost of using different sizes of pumps required and the approximate cost of operation, Table No. 3 of the Bureau Bulletin No. 22 is herewith quoted. In this table the actual horsepower of an engine is given and not the theoretical, but the cost of operating is more or less theoretical as there are but few figures available as to actual cost. Bulletin No. 89 of the Arkansas Experiment Station gives the cost of operating a 4-inch pump on a 30-foot (9.14 meters) lift for the entire growing period of 100 days, using coal. The present price of coal makes it inadvisable to use it for this purpose—crude oil or wood is recommended. The number of horsepowers required in lifting water with a 4-inch centrifugal pump increases 0.27 horsepower of each foot of lift. It is not advisable to pump water when the lift is over 9 meters, and it is essential to set the pump as near the water source as possible. The suction should not be over 3 to 4 meters.

TABLE NO. 3

Duty and cost of operating centrifugal pumps lifting water less than 6 meters, counting 3 meters as minimum lift.

Diameter of discharge		Discharge per minute in cubic meters	Actual horsepower of engine required for 3 meters lift	Quantity of water pumped in 24 hours (hectare-centimeters)	Area Irrigated in 80 days (hectares)	Cost per day of 24 hours for kerosene engine				Cost per hectare for period of 100 days
						Fuel		Engine oil, attendance, etc.	Total cost per day	
Centimeters	Inch					Liters	Cost			
10.1	4	1.65	6	24	19	54.5	₱5.18	₱2.00	₱7.18	₱30.23
15.2	6	4.11	12	59	47	109	10.36	3.00	13.36	22.74
20.3	8	7.19	22	103	82	200	19.08	3.50	22.58	22.03
25.4	10	11.36	35	164	131	318	30.24	4.50	34.74	21.21

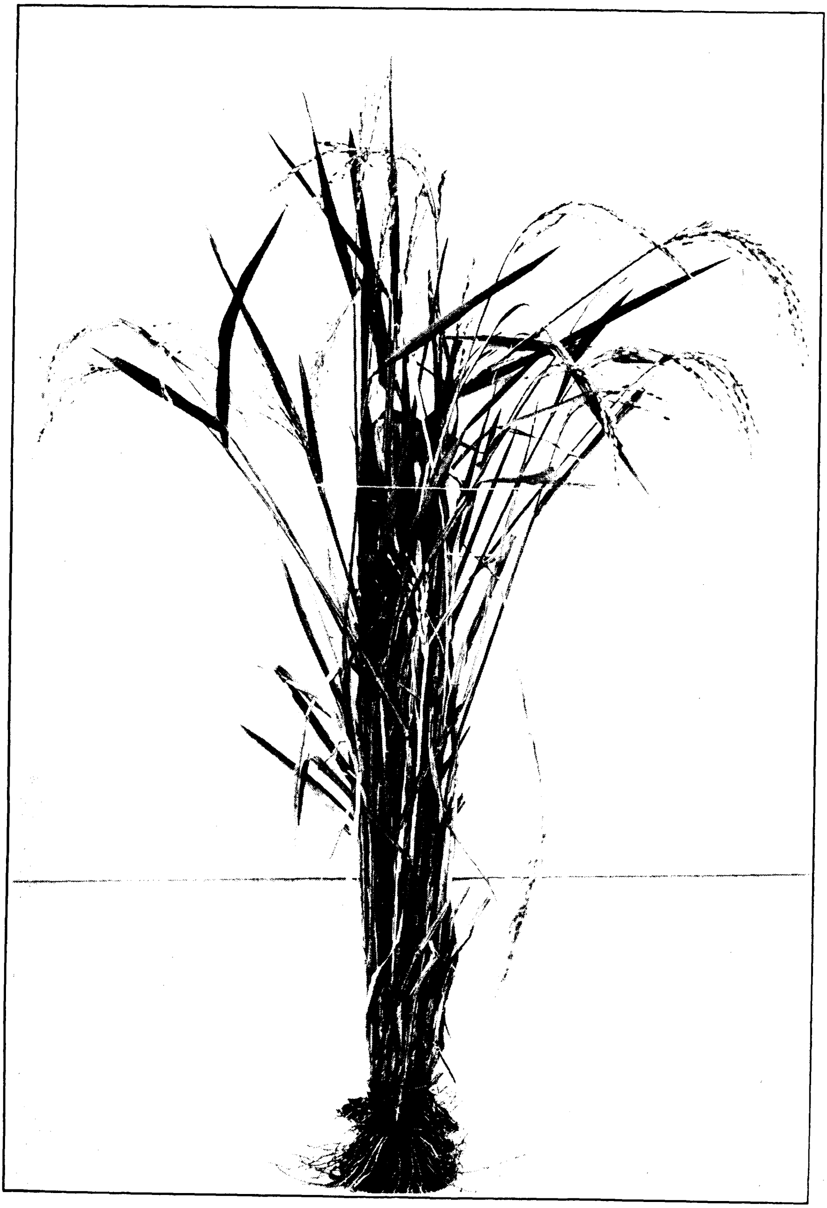
In rice culture the size of the fields depends on circumstances—the slope of the land and the character of the soil as regards drainage and irrigation. It is essential that the entire surface of the field should be nearly at the same level so that the water will stand at about the same depth, as otherwise the crop will not mature evenly. Hence, where the slope of the surface is considerable, the paddies must be made small. Fields must also be laid off in such a manner as to admit of effective drainage.

THREE SYSTEMS OF GROWING RICE

There are three systems used in growing rice—the hacienda, share or "kasama" and rent systems. The hacienda system is practiced by farmers who own large tracts of land. These farmers generally plant something else for their main crop, especially sugar cane or abaca. Under this system rice is planted by hired laborers, so that the whole product goes to the owner of the land, who also owns the animals and implements and pays all the expenses. He or his manager also supervises the work. This system is the commonest on the abaca and sugar plantations in Occidental Negros, Mindoro, Iloilo and Davao.

The second, known as the share or "kasama" system, is that under which the land is leased on shares. The owner of the land and the tiller of the soil are different persons but both are interested in the crop. Generally the owner furnishes the land, work animals, and seed, and the crop is equally divided between owner and tenant after the former has first deducted an amount of seed equal to that planted and enough more to balance the planting expenses. The owner of the land usually has more or less power over the tenants. For one thing he generally decides the kind of seed to be used and directs the methods, etc., of planting and harvesting.

Showing the effect of too close planting of lowland palay



The result of planting an excessive number of seedlings in the hill

Sometimes the crop is also divided into three—one-third for the labor, another third to pay for the work animal's labor, and the other for the owner of the land. If the tenant possesses the animal, he thus gets two-thirds of the rice crop and the landlord one-third, and vice versa. In some provinces the tenants harvest and thresh the crop, but sometimes this is done under some special agreement. Additional harvesters are often employed, generally for a share of the product varying from one-tenth to one-half, but the most common is one-eighth to one-sixth, as in Bulacan, Rizal, and Nueva Ecija. In Cavite generally one-fifth is given to the harvesters. There are times when harvesters are scarce, so that the owner gives even one-half of the crop just to save it from getting over-ripe.

Under the "kasama" system when the land is very fertile the owner sometimes gets one-half of the crop even if the animal belongs to the tenant. When the land is poor or far from the town, the landlord only receives one-fourth or even less. This system is practiced in Batangas, Bulacan, Cebu, Ilocos provinces, Laguna, Nueva Ecija, Samar, Rizal, and other provinces.

The third system, known as the rent system, is that under which the renter pays money or agrees to give part of the product for the use of the land. In most places the rate of rental is from ₱5 to ₱25 per hectare or one cavan of palay for every ten cavans produced, or three cavans of palay for every cavan of seed planted. The amount of rent depends sometimes upon the fertility of the soil and nearness to the town. Generally the renter furnishes his own work animals. This system of farming is common in Bulacan, Batangas, Cavite, Leyte, Laguna, some parts of Nueva Ecija and Pampanga.

It is estimated that probably about 90 per cent of the cultivated land in the Philippines is cultivated on either the share or the rent system—about 75 per cent under the former system and about 15 per cent under the latter. The remaining 10 per cent is cultivated by hired laborers (hacienda system).

At present about 52 per cent of the total area under cultivation consists of farms of more than 1 hectare but less than 5, and about 5 per cent consists of farms of at least 5 hectares. In Ilocos Norte are found the smallest farms in the Philippines. They average about one-half hectare each.

Farms containing from 1 to 5 hectares are found in Albay, Antique, Agusan, Capiz, Cebu, Cagayan, Isabela, Mindoro and Surigao, while farms containing at least 5 hectares are common in Davao, Iloilo, Nueva Ecija, Occidental Negros, Tayabas, Zamboanga and Zambales.

PLANTING METHODS

There are four general methods of planting rice, known as the "caiñgin" or mountain planting; the dry planting, sometimes called "upland" or "secano" or "hasik" or "dalatan" (non-transplanted); the "sabog" (palay broadcasted on the rice paddies); and the "tubigan" (transplanted).

CAIÑGIN PLANTING

(Old method)

The "caiñgin" is the most primitive method of planting rice. Only a very few people are still using this method, though crops of rice grown in this way sometimes exceed in yield those grown in the regular paddies, the soil being richer; for the process is slow and laborious and the practice is prohibited by the Bureau of Forestry, as being destructive to forests, with all that implies. It is generally practiced in those sections of the hills where the land is covered with a thick growth of underbrush and where the land slopes so much that plowing is impossible. During the dry season the underbrush and trees are cut down and allowed to dry and then the dried leaves and grasses are burned and the larger trees are piled up and burned afterwards. Planting is done between the stumps as soon as the first rain falls. The ground is not plowed at all. Holes are made in the ground with a sharpened stick and three to ten grains of rice dropped in each and then covered with dirt by the feet of the planters. Generally any upland variety can be used for this planting but there are some varieties especially adapted thereto. The land is generally planted for not more than three years and then allowed to cover itself again with a young growth of saplings for three or four years. After that length of time the land may be cleared of underbrush and used again.

DRY OR UPLAND PLANTING OR "SECANO"

(Non-transplanted)

There are two methods of planting upland rice, drilling in the seed and sowing broadcast. No dikes are needed, as in the case of irrigated rice, the rainfall being depended upon. The average yield obtained under present conditions is less than that from lowland rice but it is believed that some upland varieties can be made to produce more than the lowland if conditions are favorable and the seed is planted as it should be. The same varieties used in this method of planting may be used for caiñgin planting but each method has varieties especially suited to it. Light soils give better results for this kind of planting.

The drill method is practiced in some localities. Shallow furrows are made by means of a plow and the seed is sown by hand and then the field harrowed with a native harrow. The process is very slow but good results are obtained as the seed is planted at the right distances, and enough space is left for weeding. For this method a seed-drilling machine, like that used in the States for corn, oats and wheat, could be used to advantage, as also an ordinary one-animal cultivator.

BROADCAST OR "SABOG"

This is of the lowland method practiced in rice paddies for planting the second or short-season crop in some sections where irrigation water is not abundant. It is generally used in the provinces of Cavite, Laguna, Pangasinan, Iloilo and Capiz.

The "sabog" method is practiced in areas already having dikes, and generally planted with lowland palay during the regular planting season, the seed being broadcasted. The soil is plowed and harrowed until well puddled, as in the lowland planting. Then the seed of some early-maturing lowland variety is sown broadcast and water is turned on, if available, in sufficient amounts to maintain a submerged condition of the field after the plants have grown large enough. This method of planting is very uncertain as if the land is not provided with sufficient irrigation water and if the rain fails the crop suffers and there is thus a very poor yield. The most common varieties used for this kind of planting are the Binicol I, Dinagat I, Pinursigue, Sinadyaya and Mangasa.

The land is prepared with as little water as possible, and the seed is sown at the rate of 35 gantas per hectare. Enough water is then turned on to sprout the seed. This crop is given only a minimum amount of water during the growing season. If irrigation water is abundant it is more profitable to transplant both crops, using the "dapog" method of seedbedding, which will be described later, as transplanted rice gives a heavier yield. Some of the lowland or transplanted varieties of rice may be sown broadcast direct to the paddies. In this case the crop matures earlier than when transplanted. Some upland varieties may be also used for this kind of planting.

Weeds and grass do not give much trouble in those sections where there is a pronounced dry season and where irrigation water is not available, provided that the land is well prepared. The rice is harvested about the close of the rainy season and the fields are used for pasture during the rest of the dry season, so that by the time the farmers are ready to begin to prepare for the next crop, the land is fairly free from weeds and grasses.

As no plants can mature seeds under such conditions, there is very little to interfere with the following crop, especially where irrigation water is abundant.

The fact that irrigation water is not always available seems to put the farmer at a disadvantage, yet the exposure of the soil to the air and sun allows bacterial action to go on and leaves the land in better shape for the next crop than if it had been under water for the entire time, as would be the case if two crops were produced under irrigation. Where only one crop is grown and the fields are allowed to lie idle during the dry season, rice does not seem to exhaust the land to a great extent. Cases may be cited where large areas have been grown to rice for at least one hundred years without the use of fertilizers and still produce good crops, due to the effect of the sun and air on the soil during the dry season and the food material contained in the irrigation water. Most of the rice paddies generally crack open during dry season. These cracks are sometimes ten centimeters wide and may be as deep as 1 meter, depending upon the length of the dry season and the character of the soil.

LOWLAND PLANTING

(Transplanted)

The fourth method is that used for the lowland, or transplanted rice, known by the Tagalogs as "tanim" or "tubigan" and "tatum" by the Visayans. It is estimated that about three-fourths of the rice crop of the Philippines is produced by this method of planting. The seed is generally soaked in water for 24 to 36 hours to start germination, and then sown in the seedbed. It takes about 20 to 25 gantas of seed to plant a hectare of land and these require about 400 square meters of seedbed. The seedlings are allowed to grow on this for thirty to forty days, depending upon the length of time the variety takes to mature, before they are transplanted to the permanent fields.

Transplanting rice is, of course, an expensive and rather slow process, but so far no machine has ever been invented for planting rice in the mud. It needs about twelve professional transplanters to plant a hectare in one day. The transplanting is sometimes done by hired transplanters at forty to sixty centavos a day, with one meal, but in some places there can still be found one of the old-time coöperative organizations, sometimes even provided with a guitarist, for speeding up the movements of the planters, as shown in Plate I. In this case there is no expense except for one meal and an afternoon lunch called "merienda."

In the preparation of new land for planting, all stumps and grass roots are removed. This is naturally quite difficult in some sections due to lack of labor and for this reason some stumps are not removed at all but burnt or allowed to rot. The system of hand culture followed in the transplanting method generally permits of a muddy condition of the field, but if the use of heavier plows and rice drills is contemplated this would not be possible.

Weeds are not so harmful in lowland rice as in upland planting as the water keeps down the weeds, but if the paddies dry up due to the lack of water, weeds have to be pulled up by hand in order to obtain good crops. In Luzon rice does not do well after cogon (*Imperata cylindrica*, Koeinigii Bentham), but in Mindanao the Moros plant rice on cogon land with good results, probably due to the fact that the soil is very fertile. The cogon sod is first cut off by the Moros and the land dug up or plowed and the seed sown broadcast.

New land is planted to lowland rice by first burning the brush during the dry season. Then when the rains commence the land is generally plowed under water once and harrowed thoroughly, and small dikes are built to hold the water. In building the dikes; water is used for leveling and as a result the paddies are small and more or less irregular in shape, depending, of course, upon the contour of the land. If a farm level, such as the "Bostrum," costing about ₱200, were used, the dikes could be run on a level around the hill and small cross dikes could be put in at convenient points. The advantage to be gained by the latter method is that longer paddies may be laid out; thus time is saved in turning around at the ends when plowing, and much quicker work can be done.

The main problem in farming lowland rice is the dikes. The contour of land makes the planting more economic as about 20 per cent of the time of the plowman is consumed in turning at the corners of the paddies. The size of dikes at present are about 10 by 20 and even smaller. When the contour permits it is advisable to make paddies as large as possible—the larger the better, but about 15 by 100 meters is big enough, as this can be plowed in one day. In California each dike generally contains 10 to 15 hectares.

The following calculation is quoted from Bulletin No. 22 of the Bureau, taking as an example a paddy that is about 10 by 100 meters, about one-tenth of a hectare. If the plowman cuts 15 centimeters at one time, then he will make about thirty-four rounds with the plow. In doing this he will make one hundred and thirty-six turns. Supposing it takes thirty seconds to turn he will consume sixty-eight minutes in turning, or about 12.6 per cent of his time. If the same ground were cut up into three paddies of 16 by 33.3 a meter, he would make 408 turns, taking two hundred and four minutes, or 37.7 per cent, of his time. This loss of time may be reduced by making the cross dikes low so that the carabaos may pass over them easily and will be able to plow longer strips.

The building of dikes is rather difficult and expensive, but once built they last for many years. Dikes increase the value of land to almost double its original value. Generally these are made about 20 centimeters thick and at least 15 to 20 centimeters high. They are usually built by hand or with the aid of a spade. They may be built cheaply when tractors are used, by taking a ten or twelve-inch plow to throw six furrows together, thus forming a broad, low ridge over which tractors can run easily without destroying the dikes. This practice of making the dikes a broad ridge is practiced in the States, as it permits the use of machinery. Dikes entail some waste of land but they make plowing and harrowing very much less expensive and permit the use of heavy machinery, so that it would be advisable to use modern machinery on such level land as may be found in many parts of Bulacan, Nueva Ecija, Pampanga, Tarlac and Pangasinan.

THE SEEDBED

The seedbed should be located in a convenient place near the planter's house, if possible, so that it can be better watched and protected from animals. It should be fenced with bamboo or with at least two lines of barbed wire. For this purpose a fairly rich paddy which can be watered or drained off any time without difficulty should be selected. A light soil is preferable, as the seedlings can thus be pulled up with very little damage to the roots. The seedbed should be kept free from rubbish, weeds, etc., and well puddled, leveled and smoothed, with its edges slightly lower than the middle to allow proper drainage. The paddy intended for a seedbed may be leveled by the use of a banana stalk or a piece of board.

Seedbeds for lowland rice are generally repaired in three ways: The most common one is that by which seed that has previously sprouted is sown in a well prepared paddy and allowed to grow for thirty to forty days, when the seedlings are pulled up and transplanted into the permanent field. This is known as the ordinary seedbed or "punlaan" method.

The young plants should be allowed to make a good start, for when stunted they never develop well. Most planters know this, hence they spend about twice as much time preparing the seedbed as they do a similar area for transplanting.

About twenty to twenty-five gantas of seed, depending of course upon its percentage of germination is the quantity required to plant a hectare and this should be sown on about 400 square meters or about one-twenty-fifth of the area to be planted. The amount will also depend somewhat on the variety, as the plants are set out wider apart in poor soil or when the variety matures late. One cavan of palay contains about 2,000,000 grains, and not over 75 per cent will germinate if it is unselected seed. There are approximately about 250,000 hills 20 centimeters apart, in one hectare, so that in planting selected seed of ordinary sized grain two to four seedlings to the hill, about 20 gantas will be required to plant a hectare. When using selected seed or a late maturing variety less than 20 gantas are needed. The seedbed should be plowed at least three times if possible, and puddled with a native harrow known as "suyod," as shown in Plate VII. If the soil is light, the seed may be sown in a comparatively dry bed, but if stiff it will be necessary to puddle it before transplanting. The seed should be first soaked in water for 24 to 36 hours to hasten the germination and then as much of the surplus water as possible drained off and the seed put in a shady place until fully three-fourths of it has germinated. It should be sown as uniformly as possible and just enough water let in on the seedbed to saturate the ground.

The seedbed should be kept well supplied with water but not flooded, and the seedlings should not be transplanted too young nor too old. The age depends upon the length of time it takes each variety to mature. Under ordinary conditions, however, they should be transplanted as follows: Seedlings of early varieties, maturing in from 120 to 145 days, when at the age of about 30 days; those below 120 days in 25; those that mature in from 145 to 170 days when at the age of from 30 to 35 days, and those in 170 to 180 days when at about 35; while those that mature in over 180 days should be transplanted when about 40 days old.

When the field is ready for the transplanting the plants should be pulled up and tied together in bundles about 10 centimeters in diameter. If the plants are of full age and well developed, about one-third of the top should be cut off. This trimming checks evaporation through the leaves and also prevents them from being blown down by high winds before they take root.

The second method is what can be called the "dry seedbed" method. This is used for the bearded varieties and is generally practiced by the Ilocano and Pangasinan farmers, and is as follows: A fairly high place is plowed and harrowed dry, as for corn, sugar cane, etc. The seed is sown on the dry seedbed and harrowed in long plats about 1½ meters wide to from 10 to 20 meters long. The method differs from the one just described in that the soil is not puddled nor flooded and the seedlings are pulled up from the dry seedbed. This method is not advisable as very often the seedbed gets too dry for the young plants and the soil so hard that the roots are damaged in pulling them up.

The third method is known as the "dapog" system of seedbedding, and is as follows: A plot near the irrigation ditch is harrowed and then leveled for the seedbed. Proximity to the irrigation or inlet ditch is a necessary requirement because the water is not likely to become so hot there at midday that it will scald or otherwise seriously affect the germinating seed. The seedbed is prepared in the usual way by puddling the soil thoroughly. After this is done banana leaves are laid over the surface of the mud and allowed to sink about an inch deep to let the mud run over the leaves. These leaves are placed with the edges toward the center of the bed, the split midribs thus forming a raised outer border. The ends of the long narrow beds so formed are closed with similar split leaves placed crosswise.

It takes from 15 to 30 liters more seed to plant one hectare by the dapog system than by the ordinary method. The seed, generally of some early maturing variety, placed in a burlap sack, is first soaked in water (preferably slow running) for about 24 to 36 hours, to hasten the sprouting, and then removed and laid aside in the shade. At the end of another 36 hours, or when at least 75 per cent of the grains have shown signs of germination, the seed is sown. Seventy-five liters of seed are sufficient for seeding two dapog seedbeds, each measuring fifteen meters in length and one meter in width. It is better to sow the seed in the afternoon and it should then be carefully and thoroughly sprinkled with the muddy water from around the beds. The bed should be covered in such a way that the edges of the leaves should not meet in the center and the space thus left barely covered with plain leaves from which the midribs have been completely removed so as to leave no ground exposed. If the leaf-strips are badly torn, these tears are to be covered with loose pieces of leaves. In fact, it is better to cover the entire bed with two or three layers of leaves.

After the bed is covered with the banana-leaf mat it is again covered with a layer of either clean rice chaff or finely chopped rice straw, if this is available, to a depth of from two to two and a half centimeters. A thick sowing of the sprouted seed is then carefully made on this surface. This is necessary in order to give the young seedlings growing in such a light and loose medium a firmer stand.

In those months when the rays of the sun are intense, especially between ten o'clock in the morning and two or three in the afternoon, it is generally necessary to build a light screen about 50 or 80 centimeters over the beds so as to protect the growing seedlings from the excessive heat. This screen can be made of banana leaves placed on a light bamboo frame. More necessary than shade, however, is a proper supply of water, and much care and attention should be exercised in watering the seedbeds, especially during the first few days after sowing. This watering should be done several times during the day, with regular garden sprinkling cans if available. When the young plants are no longer in danger of being washed away, they should be irrigated with slow-running water until transplanting time, if possible, as water standing on a hot day gets so hot it is apt to half cook the young seedlings. Much care should be taken in watering so as not to drown out the young plants. The seedbed should nevertheless not be allowed to run dry for any considerable length of time at any stage of the growth of the young plants or else the seedlings will be fatally injured, especially if there is no shade during the heated part of the day. The rice chaff or the finely chopped straw used is practically the only medium in which the young plants live, as they are, of course, deprived of the soil moisture by the underlying mat of banana leaves, which, in a sense, forms a "hard pan" that their tender roots can not penetrate.

The dapog method of seedbedding makes it possible to transplant seedlings at a much earlier stage than the ordinary method without injuring them in any way when removing them from the seedbed, because the seedlings can not take deep root on account of the banana leaves. They can generally be transplanted when at the age of only 12 to 15 days without breaking their tender roots, whereas if planted in the regular seedbedding method the same variety can not be transplanted before they are thirty days old, lest the tender roots be broken off in pulling the plants up, which would weaken the young plants so they would give a poor stand. The banana leaf-mat underneath naturally makes the roots run laterally rather than downward, and thus the roots of neighboring plants soon interweave, and the seedlings are kept in an erect position. The entire bed is thus a long, narrow, carpet-like sheet of young plants, which can be easily lifted and removed from the underlying banana leaves. At transplanting time the "carpet" or "mat" of seedlings is torn into strips of convenient size, hung across the arms and shoulders of the transplanters, and thus conveniently carried to the field. Small strips are also loosely rolled up with the foliage inside and transported to more distant points. In this case the strips are unrolled as soon as they reach their destination. Here the strips are further divided into pieces about the size of a small plate and scattered over the paddies in the same manner as the bundles of ordinary seedlings. The transplanters pick up these small pieces as they go along, holding them flat on the palm of the left hand and stick four to eight seedlings at a time by means of the thumb and first two fingers of the right hand into the mud to make the hills.

The final harrowing and puddling of the field is generally done on the same day as the transplanting, or part of it may be done the day before. The dapog seedlings are ready to be transplanted from ten to fourteen days after the seed is sown in the seedbed. When the young plants are in good condition and properly handled, they should be transplanted when they are from fifteen to twenty centimeters high. If not transplanted about the twelfth day, dapog seedlings are apt to weaken, as they will crowd each other too much in the seedbed and thus be short of food material.

Once the seedlings are all removed the banana leaves can either be taken up or harrowed in, and the entire paddy planted. If the seedlings have for any reason grown very tall, the upper portion of the foliage should be trimmed off before they are transplanted; otherwise this is not necessary.

The growing of two crops of rice a year has long been practiced in those parts of the Philippines where sufficient irrigation water is available the year round. In certain towns of Tarlac, Pampanga and Laguna, for instance, preparations for a second or dry-season crop after the first is harvested are made. Naturally early-maturing varieties of lowland rice are used for this purpose for two obvious reasons: first in order that the harvest may be gathered before the rainy season begins and second, to allow ample time to prepare the land for the main crop.

Direct culture, in which the seed is sown broadcast by hand on the permanent field after the soil has been puddled and leveled, is the method employed in growing the dry-season crop in some parts of Tarlac, Pampanga and Laguna and especially in Cavite, except in the municipalities of Calauan and Bay, Laguna. In these two towns the crop is generally planted by means of the "dapog" system.

It is important to use an early variety for a dry-season crop. That the young seedlings can be transplanted so early is one of the advantages of the dapog method, as the age of the seedlings directly affects the maturing period of the rice crop. The older the seedlings are when transplanted the later will the crop mature. The writer has observed a difference of as many as 20 days in the time taken for maturing between crops planted by the dapog and by the ordinary method.

In the dapog system, the fields have to be prepared earlier as the seedlings are transplanted very much earlier than in the ordinary seedbed method. In the absence of rain, the field is irrigated, and then plowed and harrowed or otherwise prepared as for a regular-season crop.

This method should be used when the season has already so far advanced that planting by the regular seedbed method is impossible, unless the field is provided with irrigation facilities. By this method about fifteen days' time can be saved by the planter. Generally early-maturing lowland varieties are used in this kind of planting, and the varieties Dinagat I, Nagsipot and Binicol I are recommended.

The dapog system is not commonly used by the farmers just now but the writer recommends it for places where the palay is broadcasted on the rice paddies, as in Cavite, or where the planting season is well advanced. At least a trial of the "dapog" method by those who have not as yet made one is recommended for a dry-season crop if sufficient water is available. A beginning can be made by planting a small portion of the field by the dapog method side by side with a broadcasted lot, letting the results speak for themselves. The system was tried by some farmers of Santa Rosa, Laguna, some years ago, and, despite the extra expense incurred in transplanting, it has been gaining favor among the rice growers of that municipality in planting their dry-season crop, ever since its introduction, and gradually taking the place of the broadcasting method. In Calauan and Bay the dapog is the only method practiced at present for dry-season planting, in preference to broadcasting, which was abandoned some time ago. The principal disadvantages with broadcasting are the necessity of special care in leveling the paddies and in the subsequent irrigating of the germinating plants therein, the impossibility of sowing evenly by hand and the consequent waste of seed, the impracticability of weeding, and, as a whole, the more uncertain results that generally go with broadcasting under ordinary circumstances. The rate of sowing is usually heavy so as to allow for the probable failure of many plants to reach maturity; however, if, on account of favorable conditions, only a small percentage of the plants fall before heading time the remaining plants and their heads are consequently abnormally undersized and defective, and these conditions are to a great extent at least overcome by the dapog system. In other words, conditions can be better controlled under the dapog than under the broadcasting method. Of course, one of the principal factors that will determine the profitableness of the dapog method is the amount and cost of the available labor supply in the locality. At any rate, second or dry-season growing, whether by the dapog or by the broadcasting method, should never be attempted unless there is sufficient irrigation water available at all times during the growth of the crop. The dapog system can also be practiced in growing early-lowland rice varieties during the regular season.

PREPARATION OF THE FIELD

Generally farmers pay very little attention or none at all to good preparation of the land. Oftentimes rice land is plowed only once, and then harrowed until it is well puddled, as shown in Plate XVII. Not much time and care is used in plowing—only one or two days being taken for the job and the land is planted even if it is still weedy. In the case of lowland palay, of course, it is not necessary to get rid of the weeds thoroughly as these will be kept down by the water when the field is flooded, but in upland planting success depends on the thoroughness of the preparation of the land.

In preparing the field for transplanting, if there has not been enough rain it should first be irrigated, in order to reduce the draft of the plow. The roots of the rice plants are tender and do not go very deep, so that the plowing need not be as deep as for other plants. About 10 to 15 centimeters is sufficient, especially for virgin land; but for old rice land where there is a rich, compact subsoil, deeper plowing should be practiced every third or fourth year so as to bring to the surface the virgin soil with the fertilizing ingredients for the crop. It should be harrowed after the first plowing, and the land should be allowed to stand for ten or fifteen days, after which time it should be cross-plowed and harrowed under water with a "suyod"—a native comb-like implement with long teeth about 25 centimeters long set 13 to 15 centimeters apart—until the soil is well puddled. This method gives bigger returns and also checks the weeds. Rice is a shallow feeding plant, so that it is necessary to work the soil up thoroughly before planting it, in order to insure the proper development of the roots. If the field can be allowed to stand another ten days and harrowed once more before transplanting practically all the weeds will be killed and the field will remain fairly clean, as the rice plants will begin to shade the ground a short time after transplanting.

In plowing the land it is always better to plow under as much as possible of the straw and grasses and allow them to decay, as these are sources of organic matter which improve the physical condition of the soil. The common practice of many farmers of burning all the grasses in the field during the dry season should be stopped as the nitrogen and organic matter are lost when straw is burned.

THE TRANSPLANTING

The distances apart at which the plants are set out is governed more or less by the length of time it takes the variety to mature. Some of the early varieties may be planted 15 to 25 centimeters apart and the late varieties from 30 to 40 centimeters, depending upon the number of culms each plant will throw up. Rice is like wheat or other grasses: one plant will throw up a large number of culms, if given plenty of space, but under ordinary field conditions the average is about five.

Transplanting is usually done by women and children, who walk backwards in the soft mud and poke from three to five seedlings 2½ centimeters deep into the mud with their thumbs and the first two fingers, covering as much space as they can reach on either side. (See Plate I.) Much better results would be obtained if only one or two good plants were put into a hill, as the plants would not then be overcrowded, as can be seen in Plates XVIII and XIX.

In the Ilocano provinces, where the land is seldom thoroughly puddled, sharp-pointed wooden sticks, about 20 centimeters in length, are used for transplanting rice. With these holes are made in the ground into each of which 2 to 6 seedlings are set.

How to improve upon the present method of transplanting is the hardest problem in rice culture, as there has been no machinery that has ever been invented that will take the place of hand labor in transplanting rice; the planting of lowland or transplanted palay will become impracticable when labor goes so high that the planting of rice ceases to be profitable. (See Plate XX.)

Generally transplanting is done by getting the surrounding farmers to help. No pay is given but a meal and a *merienda* are provided. When hired laborers are employed to do this work, the cost depends on the daily wages in the locality. In Central Luzon, transplanters—generally women—can be hired at from 40 to 80 centavos a day, with a meal. It takes about ten to twelve professional transplanters to set out a hectare of seedlings. But where music is furnished, at least 20 per cent more work can be accomplished by the same number of transplanters. (See Plate I.)

WEEDING

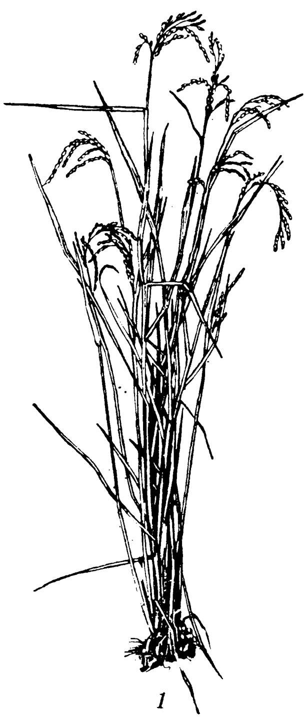
Weeds are not so troublesome with lowland rice as they are with non-transplanted, as only very few weeds can stand growing under water the same length of time that rice can. On upland palay fields, weeds grow faster and are so hardy that they are not easy to control. Their eradication is expensive and hard when they have kept pace with the palay. To get rid of weeds is one of the most important problems of upland planting, as they increase the cost of production and lower the grade and amount of rice produced to a great extent. Sometimes when land is too weedy, which condition often occurs with new land, it is impossible to save the crop. Weed trouble is not so great, where upland palay is planted in drills and is cultivated by animals.

In this connection, it is essential that the seed to be used be thoroughly cleaned of weed seeds, as seed rice is one of the sources of weeds, especially when seed is taken from the general stock. Irrigation water is another source, as it may carry seed from plants growing along the irrigation canals.

The overrunning of a field with weeds may be minimized by plowing it carefully and by using only cleaned seed. In order to kill the weeds, plowing should be done crosswise and grasses and weeds turned under in so far as possible, and the land then left to lie fallow for two or three weeks, when it should be replowed. By this time all weed seeds should have sprouted, so that if the field is plowed or harrowed once more practically all the sprouting seeds will be killed. If the land is too weedy, let it lie fallow for another two weeks and then replow and harrow it thoroughly preparatory to planting. By this time the land should be in a pretty clean condition. Some weed seeds, however, take longer to germinate. New land should be prepared in this way, as it generally contains weed seeds. The success of

Newly transplanted field in Cainta, Rizal

Selecting seed palay before harvesting the crop



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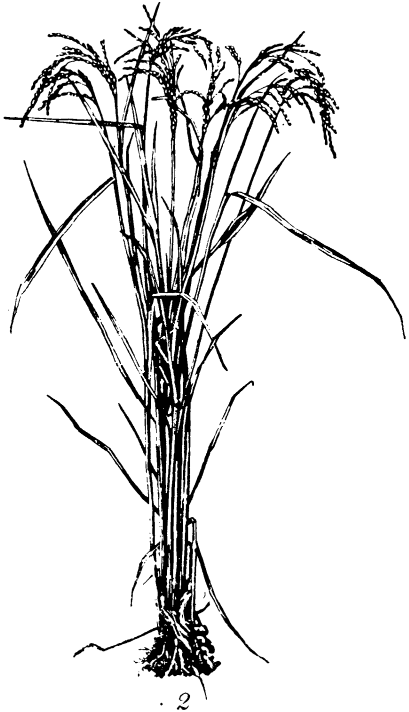

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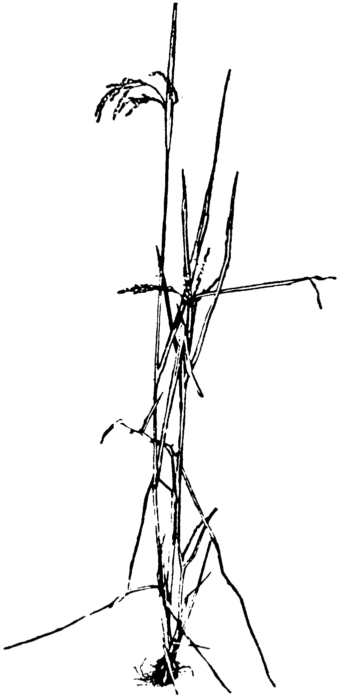
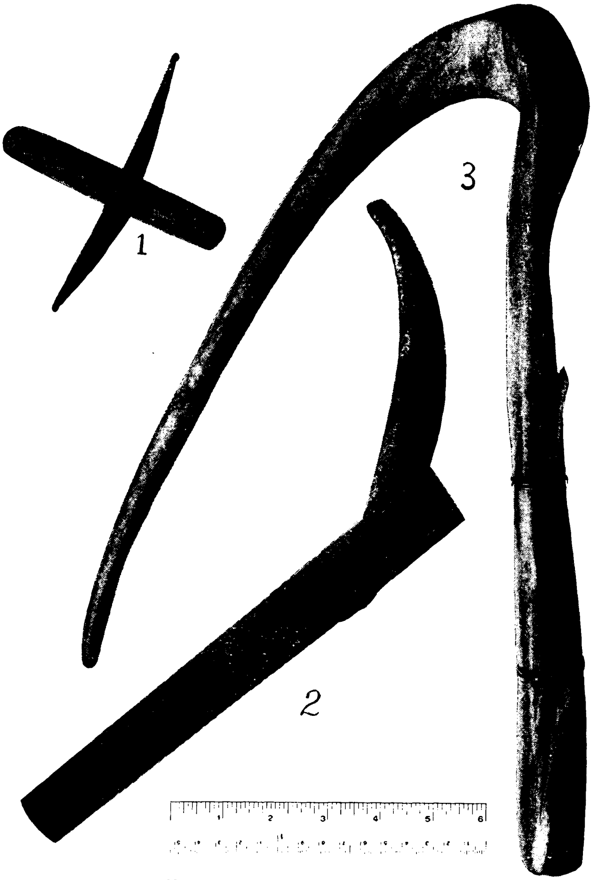


3

1. An undesirable plant to get seed from—heads not in a uniform height
2. An ideal plant to select seed from—with heads in uniform height
3. Seed must not be taken from plants of this type



Tools used in harvesting rice

(1) "Yatab" and (2) "Caret"—both implements are used for harvesting upland **palay.**
(3) "Lingcao" used for harvesting lowland palay.

planting upland palay depends largely on the thoroughness of the preparation of the land.

SEED SELECTION

One of the chief causes of the low yield of rice in these Islands is the little attention paid to the selection of varieties. But since the rice seed selection campaign was started by the Department of Agriculture and Natural Resources, a great many of the farmers have found the value of seed selection as a means to increase the yield to a considerable extent. The cost of planting selected seed is no more than that for planting unselected seed, but the yield from the selected one is often almost double, or at least, very much more than from the unselected. Another advantage is that pure seeds mature uniformly. The growing of good selected seed need not be beyond the means of the poorest farmer. (See Plate XXI.)

When a variety is found to be promising—producing a good yield of good quality and having already adapted itself to local conditions, if it was introduced—the field should be gone over before harvesting and the best plants, those having six or more good sized heads of the same height and maturing at the same time, selected. (See Plate XXII.) Selection should be done in that part of the field where the crop is approximately even in height, stand, condition of the soil, and is free from diseases, so that the seed will be taken from the average portion of the field and grown under normal conditions.

Never practice mass selection; by this method you are not sure that you get the plants having desirable characteristics as you would be by the individual plant selection method described above, where the characters of the plants to be selected can be seen at a glance, so that you know what you are selecting.

Of course, this selection is only a preliminary step. In order to obtain pure strain seeds, seed selected as above should be subjected to the head-to-the-row test culture, which will be described later, in order that the desirable strain of the variety can be isolated.

Heads from medium-length straw should be taken in preference to tall straw as these are not damaged by winds and rains. Only large, well filled heads having plump grains should be selected, and the grain examined in each plant to make sure that white palay is selected. These heads should be tied in bundles and hung up where they will be safe from rats and insects.

When two hundred heads each containing about 250 grains are planted they will produce enough seed to plant one-fourth of a hectare the following season. For propagating this selected seed, the best part of the field where care can be given, so it will not become mixed with other varieties should be selected. The seed should be sown in a seedbed enclosed with dikes to keep it from mixing with other seed if the seedbed gets flooded. Selected seed should have the best care and treatment possible, because it is only under such conditions that improved seed can be obtained.

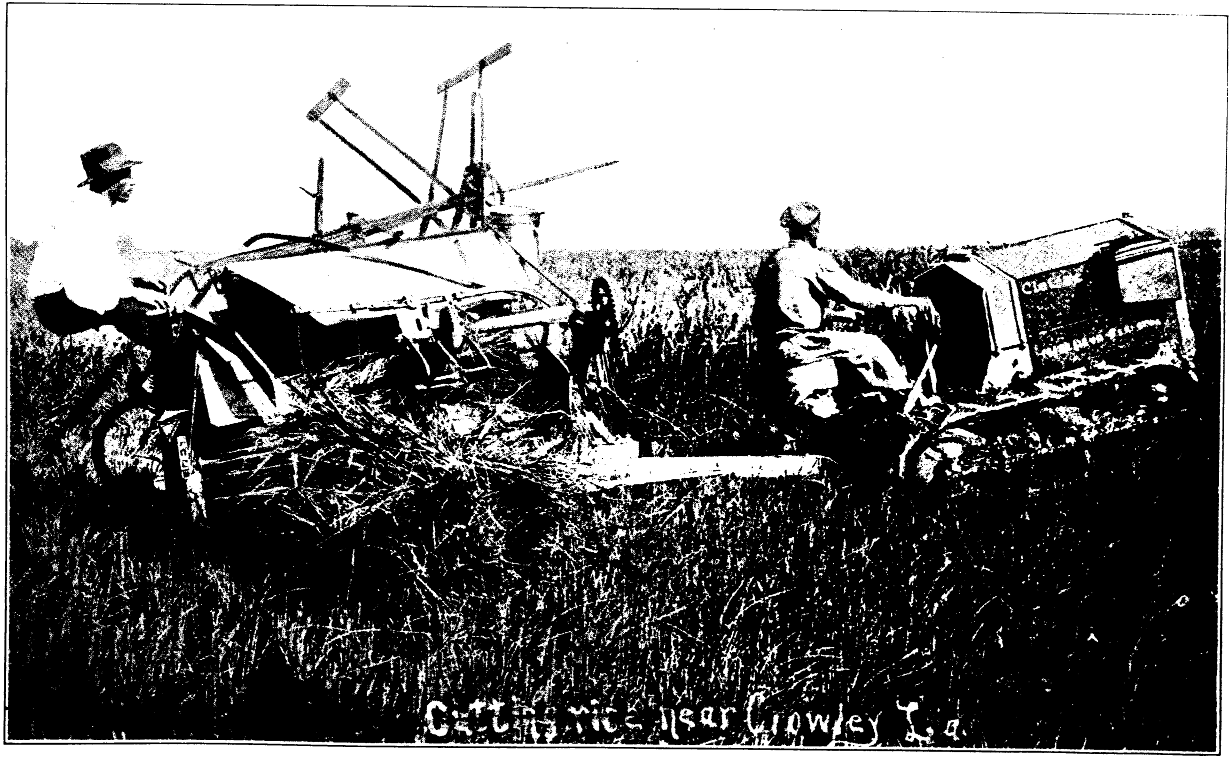
The same method of selection should be followed at least three times until a pure strain is obtained. To facilitate planting only about 200 heads should be selected at a time and the remainder of the crop saved for planting the field crop. Every effort should be put forth to make conditions as perfect as possible, for if this is done after the third year of selection the product will be of a superior strain of seed giving an increased yield and a better quality of palay. One cavan of seed thus selected will be found to be worth at least two if not three of the ordinary palay for seed purposes.

HARVESTING

One of the most expensive parts of rice production is the harvesting, as this is at present done by hand.

The use of modern machines as shown in Plate XXIV is impracticable for harvesting rice in the Philippines except for upland rice; and about three-fourths of the rice planted at the present time is lowland. Machines can not be used in the lowlands unless the dikes are taken away and the soil drained to make it hard enough to support the weight of the machinery. There are several methods of harvesting practiced—one is by cutting off the ripe heads one by one, or at the most three at a time, with an implement called a "pangani" or "yatab" as shown in Plate XXIII. This is generally used by women and children for harvesting upland or bearded palay. Sometimes the heads are cut off separately and tied together in large bundles called "manojos" weighing about 10 kilos each. These are placed in the sun until dry and are then put in the house. As a rule only bearded varieties are harvested in this way, unless the fields are under water or the heads have become so tangled together that the crop cannot be cut by the other method. The second most common method is to cut the straw about midway between the ground and the head with a kind of sickle or serrated knife fastened in the back of a crooked branch of a tree and having a hook at the end for gathering the straw into a bunch. This is known as a "lingcao." (See Plate XXIII.) The hook is held in the right hand; with it the rice is pulled up and grasped by the

PLATE XXIV



A harvesting machine at work. (Taken from the Rice Journal, Beaumont, Texas)

A series of rice stacks ready for threshing in Bigaa, Bulacan left hand, the hook is then loosened and the straw cut with the knife fastened at the back of the hook, and tied into bundles about 10 to 15 centimeters in diameter. The bundles are called "haya," by the Tagalogs. They are so uniform that they are used sometimes as a unit of measure, each containing about 0.3 kilo of threshed grain. These are left scattered on the ground to dry until well cured. They are then piled in shocks on the dikes until the harvest is over, when they are hauled to the stack yard and stacked as shown in Plate XXV. This method is generally used by the Tagalogs, it being the most practicable. Making a communal job of planting or harvesting where there are many small holdings is more or less a common practice in many provinces, but on big rice farms it is the custom to harvest on the share system, amounts varying from one-tenth to one-fourth of the crop being given to the harvesters and sometimes even one-half when hands are scarce. By this system of harvesting, a skilled harvester sometimes gets several cavans as his share for a few days' work.

In some places, harvesters are paid from ₱0.20 to ₱0.50 with the privilege of carrying away as much rice as they can carry; but in others the harvesters are paid regular wages from ₱0.60 to ₱1.50 a day. Whenever it becomes possible to use a reaper and binder, the cost of harvesting, the greatest expense, will be much reduced. And furthermore much time will be saved, as one of these machines pulled by animals can reap about five hectares a day.

CROP ROTATION

Rotation of crops is not generally practiced in rice farming as in most cases rice lands are too heavy for other plants and the land once prepared for lowland or transplanted rice is not adapted to the culture of other crops, mainly because the dikes interfere with the cultivation of other crops and to destroy these dikes every year would make the cost of production too high. (See Plate XXVI.)

Rice is rotated with some other plants, however, in a few localities. In some sections of Tarlac and Pampanga, sugar cane is rotated with rice; in some parts of Laguna and Batangas corn is rotated with rice to good advantage, and in many sections mongo is planted in the rice paddies during the dry season, as in Pangasinan and Batangas.

The planting of corn, mongo or some other beans on the rice paddies is recommended, as continuous cropping of rice without fallowing the soil is detrimental to the soil. If, however, other crops are rotated with rice the soil will then be exposed to the air for three or four months, which will accelerate the action of the microörganism which make available the nitrogen and improve the condition of the soil. By so doing the straw from the rice can be plowed under, thus saving the nitrogen and adding humus, both of which are usually lost in burning the fields over in preparing for a second crop of rice.

Most of the rice lands have been planted for at least fifty years without any application of fertilizers or rotation of crops. These soils are so deficient in food material, especially in organic matter, that the crops produced on them hardly pay the cost of production. These soils should not be planted with rice but with other crops, especially legumes. For this condition of soil the rotation with mongo is most advisable. Seed mongo is easily obtained and grown, and at the same time it furnishes a healthful food which is liked by most people, and there is at all times a ready market for any surplus product the farmer may have. Mongo grows with so little attention that it can be raised without plowing the land. Just after harvest the paddies are sufficiently moist to produce a crop of mongo.

The seed may be sown at the rate of 40 to 50 liters per hectare. It grows well with only sufficient water to moisten it—too much causes it to rot, so that all water in the paddies should be drained off when land is planted to this crop. After sowing the seed it is good to drag a big branch of a tree over the field so as to shake down to the ground all the seed which might otherwise have remained suspended in the rice straw. By merely sowing the seed, even without preparation of the field, if there is sufficient moisture in the soil, there will be a sufficient growth of mongo to keep down the weeds and to yield enough to pay for the seed used and the work of sowing and harvesting, plus an appreciable profit.

Mongo being a leguminous crop, enriches the soil by the addition of nitrogen and organic matter.

FERTILIZERS

The rice plant is not such a great impoverisher of the soil as corn and other cereals are, especially if the straw and husks are plowed under; besides irrigation water contains a considerable amount of nutritive materials dissolved in it which it restores to the soil when the fields are flooded, especially when the water comes from the river.

Barn manure will supply these elements to the soil quicker and cheaper than any other known material, but it is difficult to obtain in sufficient quantities in the Philippines.

There is much difference of opinion as to the use of commercial fertilizers on rice. The process of applying it is rather difficult and wasteful especially with lowland palay, unless the farmer has complete control of the irrigation water. It has been estimated that an average crop of 40 cavans or 1,744 kilos of palay per hectare will take from the soil 20.64 kilos of nitrogen, 10.32 kilos of phosphoric acid and 4.54 kilos of potash. If an equal weight of straw were harvested it would take 11 kilos of nitrogen, 2.44 kilos of phosphoric acid and 28.03 kilos of potash.

In Hawaii an increase of 100 per cent has been claimed where a complete fertilizer was applied. In some preliminary experiments which have been made by the Bureau of Agriculture an increase of 50 to 60 per cent has been obtained from using a complete fertilizer a the rate of 300 kilos per hectare, but the yield of rice depends upon so many factors that it would not be safe to predict just what the result would be from the general use of fertilizers. From observations made in the rice-growing districts it is believed that thorough preparation of the land, systematic rotation of crop, the proper use of water and selected seed will have a greater effect upon the yield and will be more profitable than the application of fertilizers, especially when the soil is fairly rich. If fertilizers are to be applied directly to the rice field they should consist of sulphate of ammonia, acid phosphate and muriate of potash combined so as to make a mixture containing 5 per cent nitrogen, 8 per cent phosphoric acid and 10 per cent potash. Results of experiments show that ammonium sulphate is the best form of nitrogenous fertilizer for rice.

Commercial fertilizers when applied alone will not do the work of farm manures chiefly because they do not contain humus. Rice soils need humus and organic matter as well as the other elements. Then too, if commercial fertilizers alone are applied to the worn out soil that most rice fields have, the result is likely to be a failure unless the farmer knows just how to apply them. Another objection to the use of commercial fertilizers to rice plants, is that they are so expensive that poor farmers are unable to buy them. Still another reason is that in applying commercial fertilizers one must know how to use and apply them in the most economical way, otherwise, it will not pay. Very often people who are ignorant of the use of the different fertilizers, find they do more damage than good. But, of course, they give good results if applied properly.

COST OF PRODUCTION

It is difficult to give an accurate estimate of the cost of producing palay as it depends upon the producer himself, the condition of soil he is working, the cost of living and the rainfall or irrigation water available.

The following estimates of the cost of production per hectare of the lowland, upland and the tenant systems, are based on the average cost of labor and actual experiments conducted at some of the stations of the Bureau:

Estimated cost of production of rice per hectare in the Philippines in 1920

LOWLAND

Preparation of seedbed, 400 square meters	1 m-d 1 a-d	₱1.50
One cavan seed palay		5.00
Cleaning and fixing dikes	1 m-d	0.80
Plowing one hectare of land	7 m-d 7 a-d	10.50
Harrowing with "suyod"	4 m-d 4 a-d	6.00
Lifting and distributing seedlings	2 m-d	1.60
Transplanting	14 w-d	8.40
Care of crop: irrigating, weeding, etc	5 m-d	4.00
Harvesting with lingcao	10 m-d	8.00
Stacking and hauling sheaves "haya"	2 m-d	1.60
Threshing with pioca and winnowing	5 m-d	4.00
Rental of land		20.00
Cost of 32 gunny sacks at ₱0.40 each		12.80
Total		84.20
Cost per cavan of palay produced		₱2.63

UPLAND

Seed palay, 35 gantas		₱7.00
First plowing	7 m-d 7 a-d	10.50
Second plowing	5 m-d 5 a-d	7.50
Harrowing	2 m-d 2 a-d	3.00
Planting	1 m-d	0.80
Weeding	8 m-d	6.40
Harvesting with "yatab"	16 w-d	9.60
Threshing and winnowing	3 m-d	2.40
Rental of land		10.00
Cost of 20 gunny sacks at ₱0.40 each		8.00
Total		65.20
Cost per cavan of palay produced		₱3.26

GROWING RICE UNDER THE TENANT SYSTEM

Ten per cent depreciation of implements (native plow and harrow)	₱3.00
Fifteen per cent depreciation of 1 carabao	30.00
Cost of cleaning 15 sacks of palay to put $\frac{2}{3}$ of the crop after deducting 6.4 cavans for the harvesters; 3.2 for the threshers, as share of the landlord and for the services of the animal	6.00
Total	39.00
Cost per cavan of palay produced	₱2.60

Estimating the price of palay at ₱5 per cavan it will be necessary to raise at least 16.8 cavans by the lowland, 13 cavans by the upland and 7.8 cavans by the tenant systems of planting in order to pay the expenses necessary to cultivate one hectare of land. These amounts, of course, will be higher or lower in each province according to the rate of wages.

From the above estimates and calculating on the average for the 1919 crop of 24.48 cavans per hectare in the Philippines, the cost of producing one cavan of palay, based on conditions in 1919, and using the average of three methods of planting generally practiced in these Islands will be ₱2.83 and ₱5.66 for clean rice. (The value of by-products produced will cover the cost of milling.)

REMARKS

Average wage per man daily (m-d)		₱0.80
Average wage per woman daily (w-d)		₱0.60
Average wage per man with carabao daily (m-d)-(a-d)		₱1.50
Average yield per hectare of 1919 crop	cavans	24.48
Estimated average yield of lowland palay	do	32.00
Estimated average of yield of upland palay	do	20.00
Estimated average cost of one carabao		₱200.00

100 kilos of palay produce about 62 kilos of clean rice.
100 kilos of palay produce 18 kilos of broken grains or "binlid."
100 kilos of palay produce 14 kilos of hull.
100 kilos of palay produce 6 kilos of "tiki-tiki."

The following table gives the cost of production per hectare in California, as given in Farmers' Bulletin No. 688.

TABLE NO. 4

Estimated cost per hectare of growing rice in California

Operation	Cost per hectare
Plowing	₱14.82
Preparation of seedbed	6.17
Checking	12.84
Drilling	3.80
Seed rice	9.88
Care of crop, April to September inclusive	19.76
Harvesting	12.35
Shocking	2.47
Threshing	17.29
Sacks and sewing twine	8.64
Hauling grain to warehouse	4.32
Water tax	12.35
Weeding	3.08
Total	₱127.77

The high cost of labor in California is the item that makes rice growing there more expensive than in the Philippines, in spite of the use of machinery.

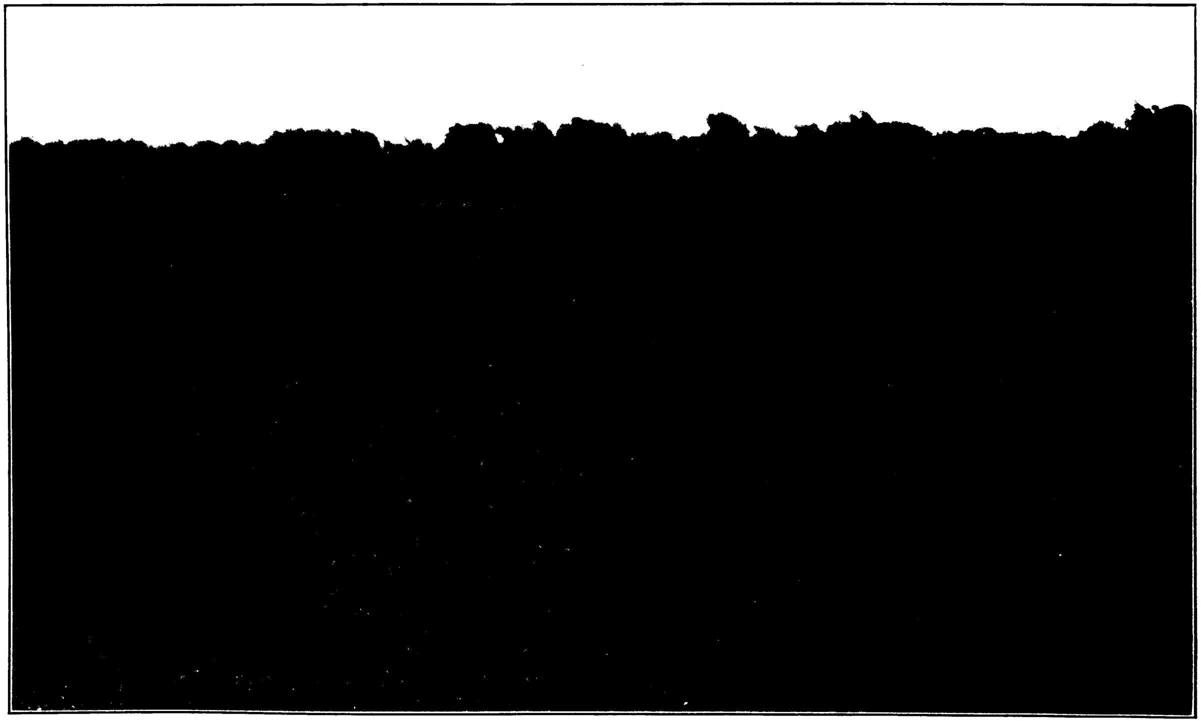
THRESHING

Several hundred modern threshing machines are now being used by some of the big rice planters in the Philippines. One is shown in Plate XXVII. At present most of them are found in Nueva Ecija, Bulacan, and Pangasinan. These machines move from place to place to thresh rice and payment for the work is made either in money or palay. Small farmers thresh their rice immediately after harvest, usually stacking the harvested crop and do it in so excellent a manner that it is not injured by rain. These stacks are allowed to remain for a month or so until it is full moon or until the weather becomes settled. (See Plates XXV and XXVIII.) Threshing is still done in most places by various simple means such as treading out the grain on a hard earthen floor by human beings or carabaos, treading on slatted platforms and beating with flails against stones or hard wooden boards.

Rice sheaves are spread on the threshing floor and the grain is trodden out by animals driven in a circle. Generally carabaos or horses are used for this kind of work. The animals go on until virtually all the grain is threshed—the small quantity left in the panicles is cleaned by hand or by the laborers' feet. Threshing in this manner is generally done by moonlight. Sometimes a wooden roller with short teeth or spikes is driven over the sheaves and as many as 20 carabaos or horses are used at one time—the more animals there are the quicker the work can be done. Fifteen carabaos or horses when used at one time can easily thresh about 200 cavans of palay in five hours.

When labor and animal power is cheap it is better to thresh rice in this way as the chances for weed contamination, seed mixing, and breaking of the kernels is less than it would be by machinery, as very often there is faulty adjustment of the parts of the machine. One carabao can thresh about 15 cavans of palay in about 5 hours. Especially when rice is wanted for seed, the threshing machine is not to be recommended, unless perfectly adjusted. Generally from 1/10 to 1/6 of the palay cleaned is given a man as his share for threshing and about 1/10 is given when threshed machine is used.

Rice should not be threshed until the kernel is hard and the straw thoroughly dry and cured. It can be properly cured in a well piled shock, even though exposed to heavy rains and the hot sun. When straw, however, is stacked while damp or green the seed will heat and lose its vitality and produce a soft chalky rice which sells at a low price.



Rice fields near the end of the dry season showing the clean condition. (Note the cracks in the soil.)

Modern method of threshing rice. (Taken in Murcia, Tarlac)

CLEANING

There are two methods of cleaning rice practiced. Poor farmers pound it in a large wooden mortar with a wooden pestle called a "mazo." The first pounding takes off the hull and further pounding removes the bran and germs. Then the hull and rice polish are removed from the kernel by winnowing. For this purpose, a native fanning mill called "hungkoy" is used. The process is rather slow and expensive so that this method is only used when rice is intended for home consumption or when the place is far from a mill. Rice so cleaned, however, does not receive as high a polish as that cleaned in large mills and costs more on the general market, mainly on account of the extra labor it takes to clean rice in this way. This kind of rice, however, furnishes a better ration than highly polished rice, as it contains more protein and phosphorus. It has been found that those who live upon an almost exclusive diet of polished rice are subject to a disease called "beriberi." It is supposed that this disease is due to the absence of phosphoric acid anhydride, which is essential to human life. The unpolished rice contains three and three-tenths per cent more phosphoric acid anhydride than the polished.

RICE MILLS

Modern rice mills are gradually superseding the old-fashioned sort and are very common nowadays, especially in the rice provinces, generally along the railroad stations. There are also some water-power mills, (See Plate XXIX) most of which are found in Cavite, Laguna and Tayabas. At present there are several hundred small mills requiring engines of 6 or 8 horsepower to operate, which clean rice for local use. They charge, as a rule, from 20 to 50 centavos for cleaning each cavan of rice, while other mills receive only the by-products as payment for the work. (See Plate XXX.)

The rice grain in the hull as it is received in the mill is termed "rough rice" or "palay." The process of milling or hulling consists of three steps. In the first the hull is removed; in the second the outer coating; and in the third the inner one. The palay goes between a pair of grinding stones, set some distance apart, which revolve, causing the grains to assume a slanting position. While in this position pressure is exerted at the ends of the grain, which cracks or splits the hull and the kernels drop out. The mill is adjusted in such a way as to prevent too much breakage of the kernel, as broken rice sells for less. After leaving the hullers the rice is screened and fanned, to free it from the bran, broken rice or "binlid" and hull. In the United States and some other countries the kernel is polished thoroughly to give it the luster that is demanded by the market. In Spain and the United States glucose and glycerine are used for polishing.

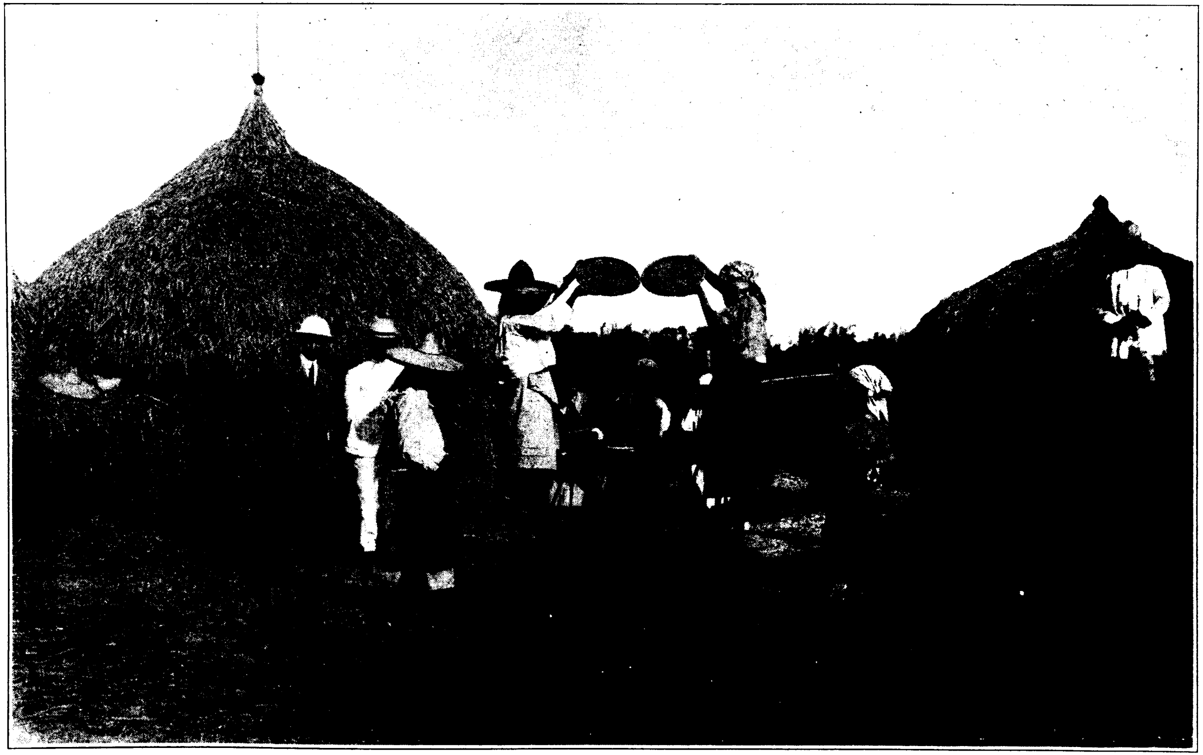
BY-PRODUCTS

The principal by-products obtained from rice are rice meal (broken rice), rice polish or bran, hull and straw. The first three are produced in the milling process.

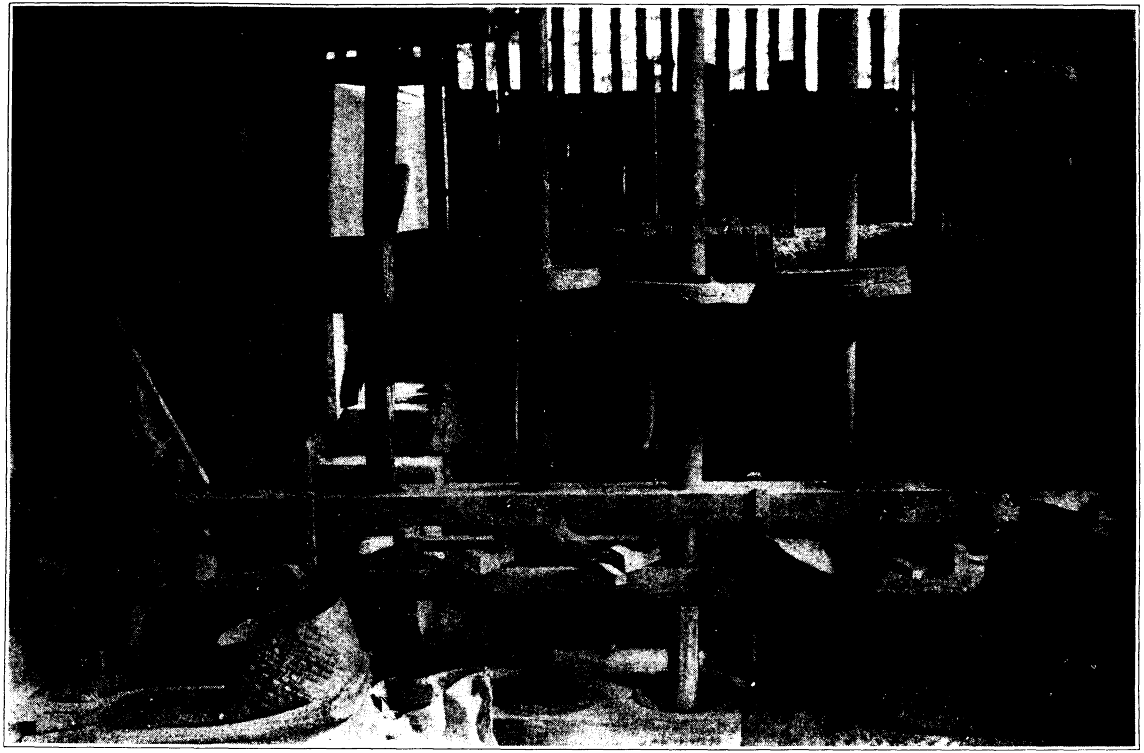
Rice meal.—This by-product is some times called broken rice, or "binlid." When palay is milled, some of the kernel is broken into small pieces which pass through the screen used in the mill. The amount of this by-product produced depends upon the adjustment of the mill and the condition of the grain, as when the mill is not well adjusted a large amount of the grain comes out broken; also when palay heads are cut unripe or when not properly cured the kernel becomes chalky and breaks in pieces while milling. Over-drying will also cause breakage. A large percentage of the embryo of the kernel is found mixed with this by-product, hence it produces a very nutritious and palatable feed; but on account of its high content of fat it turns rancid in a short time. It serves as an excellent feed for cattle and pigs, and when clean is sometimes used for human food. Its food constituents can be seen in the table of analysis given on page 46.

Rice bran.—This is sometimes called rice bran, "tiki-tiki" or "darak." It contains most of the protein and some ground kernel and hull. It also has a high percentage of fat which makes it turn rancid if kept too long. When rice is cleaned by pounding in a wooden mortar (primitive method) or when the mill is not properly adjusted, a large amount of bran is produced. It furnishes a very rich food which is liked by horses and cattle. It is also an excellent feed for young chicks and for hogs when mixed with ground corn, cooked cassava, sweet potatoes, or banana stalks chopped fine. Rice bran alone, though, should not be fed in large quantities to cattle as it is liable to cause stomach trouble, nor should it be given as an exclusive diet to young pigs. Extract of tiki-tiki is now on sale in nearly all drug stores as a remedy for "beri-beri."

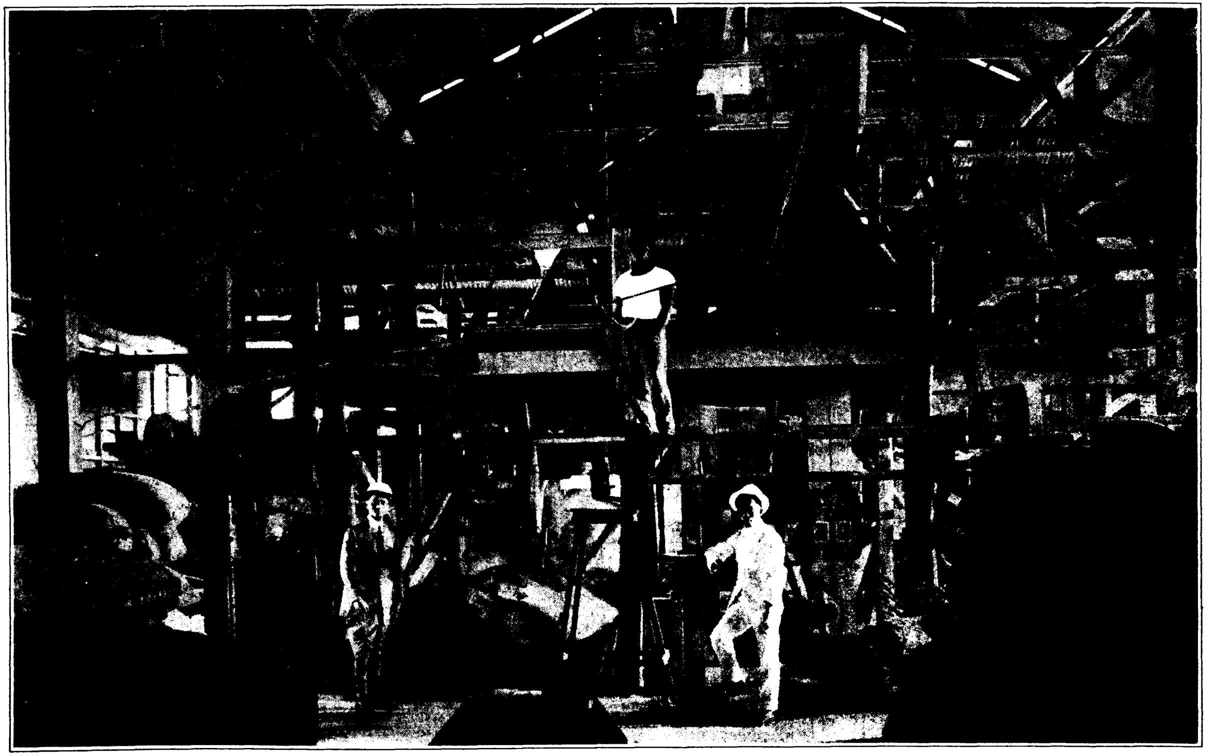
Rice hulls.—This is another by-product produced in the milling process. It is called "ipa" by the Tagalogs. Rice hulls are too fibrous and unpalatable, and contain too little digestible matter to have any value at all as a feed for animals. They are, however, nowadays mixed with rice polish to make a well balanced ration for livestock. The chemical analysis of rice hulls is given in Table 6.



Old method of winnowing rice



Rice mill operated by water power in Lucban, Tayabas



Interior view of a rice mill in Binacayan, Cavite

PLATE XXXI

1920 Variety Test experiment conducted at the Pangasinan Rice Sub-station

In modern rice mills hulls are used as fuel, hence in passing through a rice mill the attention will be invited by the large pile of hull ashes. These ashes contain about 0.82 per cent of phosphoric acid, and 0.93 per cent of potash. The low content of these elements makes ashes only a weak fertilizer, and for this reason they are not used except where labor is cheap, as it hardly pays the cost of spreading them over the fields. The best and most economical method of applying them to the fields is to strew them over the main irrigation canals and let them be carried away by the irrigation water.

Rice hulls, however, make an excellent mulch for gardens and fruit trees. It is advisable to spread them on the rice paddies as they produce humus, which improves both the physical and chemical conditions of the soil. When burned the nitrogenous matter is lost.

Rice straw.—The dried stalks of rice are known as rice straw. This is a good forage especially when cut rather green and properly cured, and therefore worth preserving. Rice straw has been a total waste until lately. Now it is sold either loose or in bales. Its high percentage of protein and carbohydrates, as given in the table on page 46, compared with other straw, makes it an excellent feed for animals. As a fodder for stock its value is about equal to that of other forage crops. No doubt in the future it will be utilized for other purposes, as it can be woven to make rice sacks and mats or made into cellulose or paper, as is done in Japan and other countries. It will be just as valuable as imported baled straw, if cut green, properly cured and baled. At present some of the straw is fed to carabaos, but the greater part remains in the fields and is either plowed under or burned.

The planter that burns his straw and hulls loses 63.92 per cent of the total food material contained therein, while if he plows them under this loss is only very little.

THE VALUE OF RICE AS A FOOD

Rice is a carbonaceous food containing as high as 77.55 per cent of carbohydrates. Polished rice contains about 6.55 per cent of protein and unpolished rice contains about 9.88 per cent. Rice is however deficient in fat and its protein content is very much less than that of other cereals; so its deficiency in nutritive value should be made up with fish, beans, and meat, etc., which contain the necessary protein and fat. It is therefore by itself not so well balanced a ration as corn or wheat, which contain as high as 10.4 per cent and 12.4 per cent of protein, respectively; but in spite of the low percentage of protein that rice contains it has two advantages over other cereals—it is easier to prepare and to digest.

Inside the grain is a thin coating containing some phosphoric acid anhydride, which is essential to the human body. This coating is taken away when rice is polished. For this reason the unpolished rice furnishes a healthier food than the polished as the latter has lost its phosphorus content during the milling process. Too much polished rice causes a disease known as "beri-beri," unless it is supplemented with some foods containing the lacking element. For this reason poor people who cannot afford to eat much fish, meat or other foods containing phosphorus are generally affected by this disease.

The following table shows the comparative food value of some cereals:

TABLE NO. 5

Cereals	Water	Ash	Crude protein	Carbohydrates		Fat
				Fiber	Nitrogen free extract	
Rough rice (palay)	9.6	4.9	7.6	9.3	66.7	1.9
Flint corn	12.2	1.5	10.4	1.5	69.4	5.0
Wheat	10.2	1.9	12.4	2.2	71.2	2.1
Rye	9.4	2.0	11.8	1.8	73.2	1.8
Barley	9.3	2.7	11.5	4.6	69.8	2.1
Oats	9.2	3.5	12.4	10.9	59.6	4.4
Sorghum	12.7	1.9	9.2	2.0	70.8	3.4

ITS VALUE AS A FEED FOR ANIMALS

Palay and its by-products are among the best feeds for animals. Its analysis compares favorably with that of other cereals. The grain is fed to animals, especially chickens and horses, in its raw stage, but it would be slightly better if it were ground. Broken rice or "binlid" when boiled is a good food for hogs, while the bran is for horses and young chicks. The following table of analysis will give the reader some idea of the relative values of the different by-products.

TABLE NO. 6

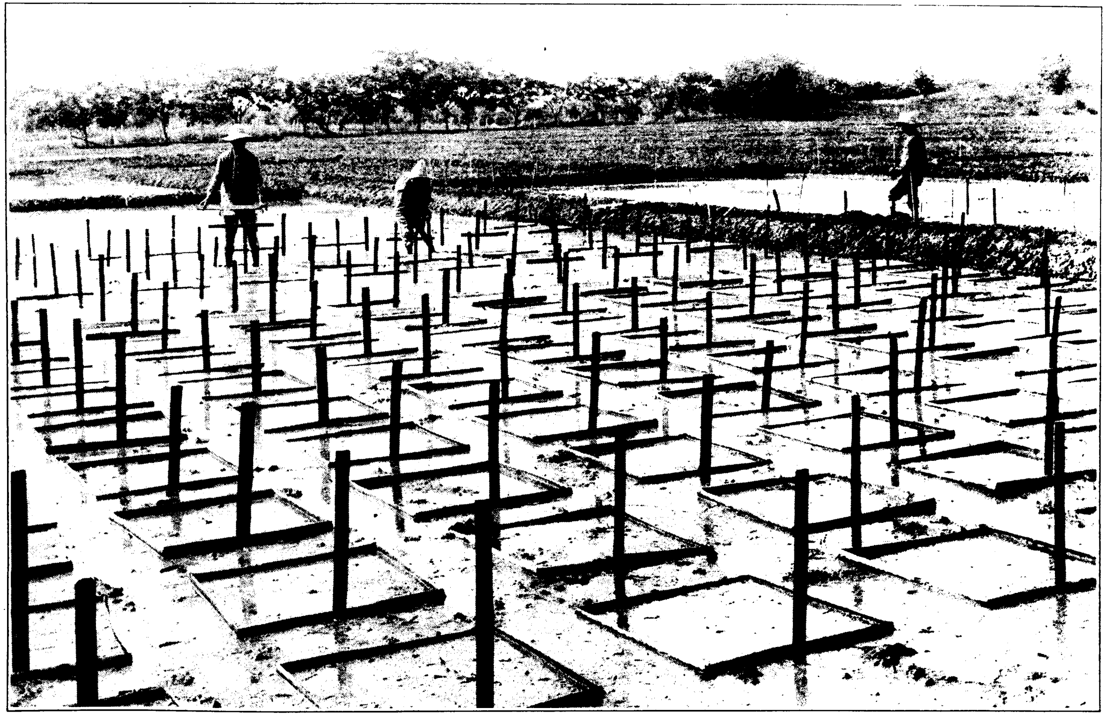
	Water	Ash	Fat	Protein	Crude fiber	Carbohydrates
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Rough rice or palay [a]	10.89	9.45	2.58	7.44	9.28	64.30
Rice straw [b]	12.80	11.94	0.65	3.20	37.11	34.30
Rice straw [a]	10.84	14.04	0.59	3.31	32.91	38.31
Rice hulls [a]	8.97	18.29	0.49	3.50	41.89	26.96
Rice bran [a]	9.84	11.35	9.91	9.88	14.76	44.26
Tiki-tiki or rice bran [b]	11.41	----------	10.98	10.88	----------	66.73
Binlid or broken rice [b]	11.79	----------	2.56	8.19	----------	77.46
Unpolished rice [a]	----------	----------	----------	9.88	----------	69.67
Polished rice [a]	----------	----------	----------	6.56	----------	77.55
Native corn	12.20	1.50	5.00	10.40	1.50	69.40

[a] Louisiana Experiment Station [b] Bureau of Science, Manila

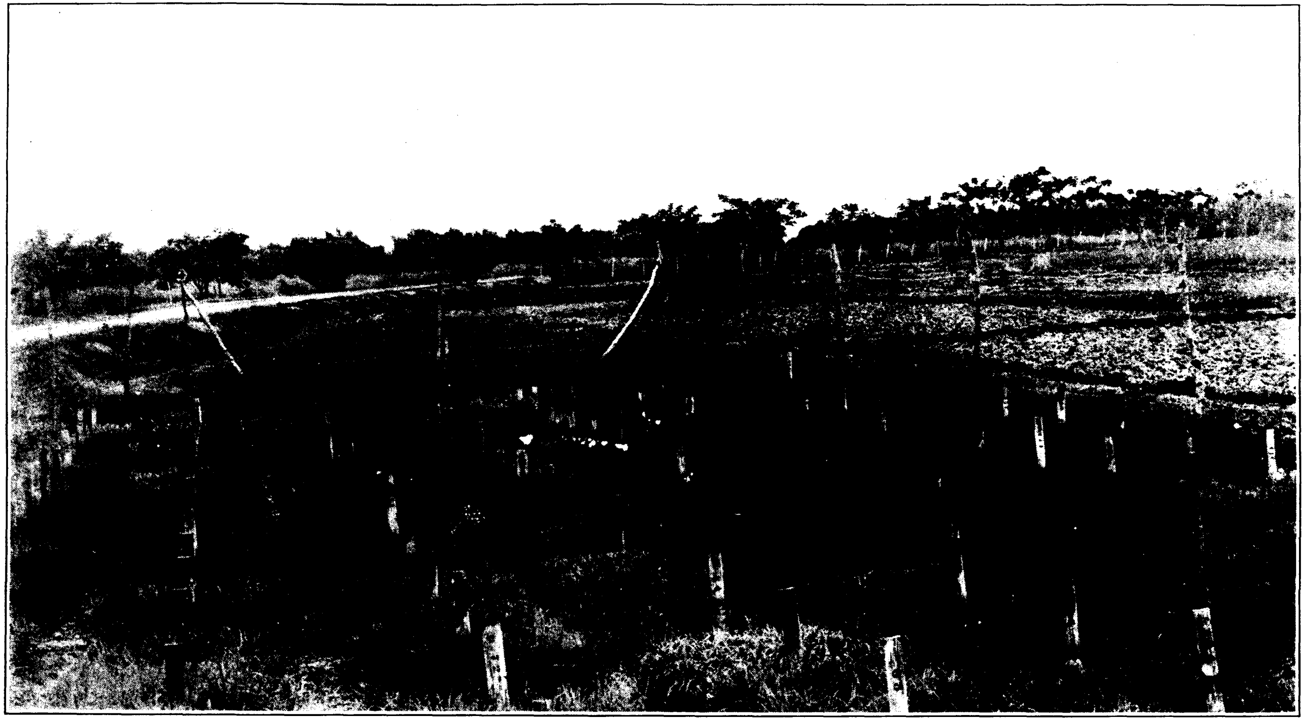
One of the fields of the Alabang Central Rice Breeding Station, where rice experiments are being conducted

PLATE XXXIII

Preparing the field for the experiments, Alabang Central Rice Breeding Station, 1920



Preparing the seedbeds for the variety test experiment at the Alabang Central Rice Breeding Station



Seedbeds for the variety test experiment, Alabang Central Rice Breeding Station, 1920

EXPERIMENTS ON RICE

Variety test.—Work on rice was started by the Bureau of Agriculture in 1909 and about 3,500 names of varieties have been recorded since then. There have been 1,282 varieties tested already, including those planted in 1919 but of this number only 991 were found to be distinct varieties while the remainder were duplicates but with different names, as previously stated.

This was verified by planting the different varieties side by side in plots having as uniform conditions as possible, where the varietal characteristics were compared and studied. (See Plate XXXI.)

Of all the varieties tested up to and including the season of 1919 about 594 were found to be lowland, 440 upland, and 171 glutinous and 951 non-glutinous. The remainder were dual purpose and semi-glutinous rices. As to quantity about three-fourths of the rice grown in the whole Archipelago is lowland.

The classification—upland and lowland—is more or less arbitrary, as some varieties will grow and do fairly well under both conditions while some only give good yields when planted according to their habitat.

The results of this test are given on Table No. 10. The number of varieties increases every year as new ones are collected.

THE LOWLAND VARIETIES

Most of the lowland varieties have been tested at the Alabang Central Rice Breeding Station, Alabang, Rizal. (See Plates XXXII and XXXIII.) The climate there is rather dry and the soil is poorer than the average rice soil, hence some of the late varieties did not develop as well as they would in moister climate, although there was a constant supply of water supplied from an artesian well. Some of the varieties were tested in Calauan, Laguna, and San Miguel, Tarlac, on an average soil for those sections.

In order to obtain an average yield of the different varieties given in Table No. 10, every effort was made to have all conditions as uniform as possible. Much time was spent in making complete records of the characteristics of each variety and such data as might be of interest to rice growers is included in the same table.

The seeds of these different varieties were planted in seedbeds about 50 centimeters by 50 centimeters square, each surrounded by a bamboo frame to prevent seeds from being borne away by water and becoming mixed with each other, as seen in Plates XXXIV and XXXV. The seedlings were allowed to grow in these squares 30 to 45 days depending upon the length of time each variety took to mature, before they were transplanted.

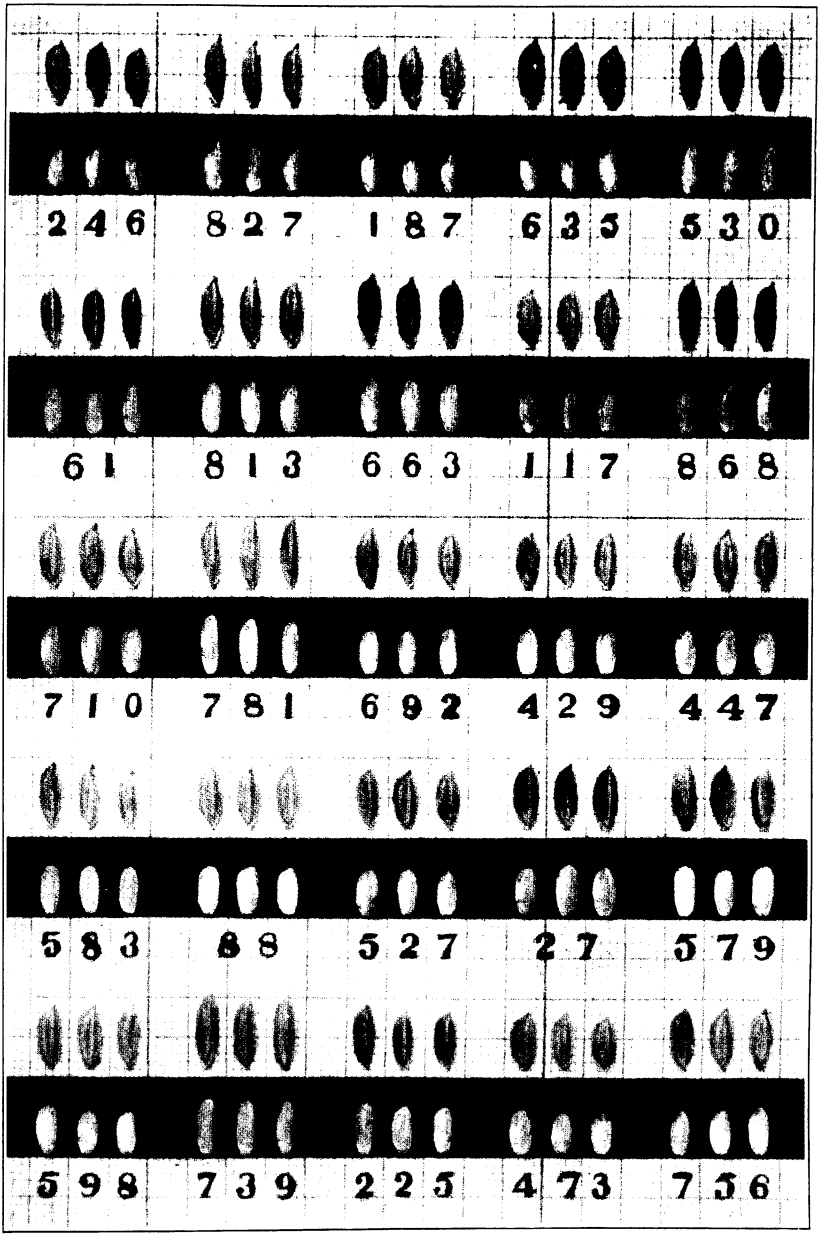
Before the seed was sown, it was first placed in a cloth bag and soaked in water for 12 to 36 hours; then it was carefully sown in the squares. Every precaution was taken to keep all the varieties under the same conditions as far as possible.

When the seedlings reached the right age for transplanting those in the center of the squares were pulled up and transplanted to permanent plots 1½ meters wide by 10 meters long.

Each plant was set out in rows 20 centimeters apart and 20 centimeters in the row. To get this spacing even, small stakes were set every 20 centimeters at both ends; then a string knotted every 20 centimeters was stretched lengthwise of the plot to make the distances between the individual plants uniform. This distance was rather wide for some of the early varieties as the general practice is to put a number of seedlings per hill, but it was necessary to plant one seedling in each hill and at the same distances apart so that comparative results could be obtained. Each plot contained 400 plants. To get more accurate results the plots were increased for the 1920 season, to contain an area of 50 square meters.

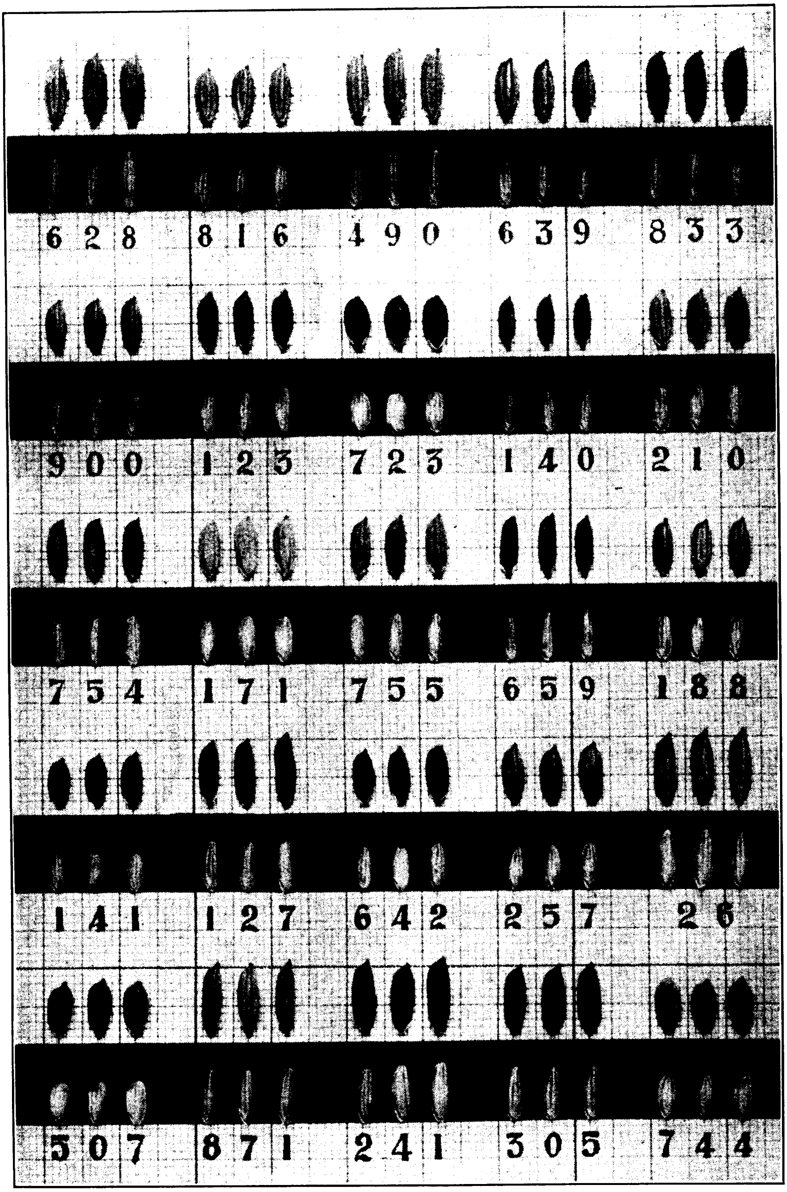
It should be understood that in field practice from three to five plants are put in a hill, but if this were done in test plots nothing could be determined as to stooling qualities or comparative yield. A careful record was kept of the date of planting, rate of growth, time of flowering, time of ripening, position of culms at harvest, strength of stalks, insect pests, plant diseases, etc., of each variety. During the progress of the growth of the plants, the behavior and other data which would indicate superiority of one over the other were recorded.

Before cutting the plants of each plot, the height and number of stalks of ten plants, picked at random, were measured and counted, respectively, to find the average height and stooling capacity of each variety. The same was done with the duplicate plots which served as check plots. Ten heads, picked at random, were taken for the counting of the average number of spikelets, grains, and length and width of the grain, etc. Then the plants of each plot were cut and all heads tied up in bundles, and the hills counted to find the percentage of living and dead plants. Each bundle was tagged according to field plot number, threshed separately and the grains weighed to find the actual yield per plot. The theoretical yield per hectare of each variety was calculated, taking into consideration the original number of plants. The yield, growing habit, length of maturity, stooling capacity, types of grain, milling, eating and cooking qualities, etc., were



Some varieties of lowland rice as described in Table No. 7

246. Caongedi; 827. Sipot; 187. Cainti II; 635. Mulan-ay; 530. Macan pina; 61. Bengala; 813. Señora II; 663. Pauni; 117. Bugaten; 868. Tinabas; 710. Postoguer; 781. Saigon IV; 692. Piniling Daniel; 429. Inachupal; 447. Inasimang; 583. Mancasar; 88. Binatad; 527. Macan I; 27. Bad-as; 579. Manabun-ac; 598. Manticanon; 739. Quinanay; 225. Calobang; 473. Joquianan; 756. Quinatia I



Some varieties of upland rice described in Table No. 8

628. Mitao; 816. Sinaguing I; 490. Kinawayan I; 639. Nagdami I; 833. Solig II; 900. Bagonhon II; 123. Bulagsac blanco; 723. Pungdol; 140. Busisi I; 210. Calibo I; 754. Kinastilla II; 171. Cabucay; 755. Kinastillo; 659. Palaguinguing; 188. Cairog; 141. Busisi II; 127. Bulao I; 642. Nagsaya; 257. Capino I; 26. Bacras; 507. Libod; 871. Tinalahib; 241. Canato; 305. Catorce; 744. Quinaoris I

the points considered in the comparison. Each variety was tested at least three years under normal conditions before it was eliminated from the test or selected for improvement.

Before the plants of a desirable variety selected in the variety test for improvement in the head-to-the-row test culture were cut the ten best plants were selected to be used as mother plants. These mother plants, as one may call them, were carefully described in detail so that the data taken from each served as a guide, in a measure, in determining the stability thereof. Data on the average height of the plants, number of stalks per stool, length and number of spikelets and grains of each head and other characteristics of the mother plants were taken to serve as a record by which the results after improving the strains were compared. About 25 of the biggest heads having the largest number of grains from the ten plants were selected and then these were divided into five stocks according to size and number of grains. Heads of each stock were tied together, labeled properly and then put inside of large paper bags with a few moth balls in each and hung in a safe place till the next planting.

The heads of all the plants from each plot were dried and then weighed to find the actual and the theoretical yield per hectare.

As a result of these tests on 1282 varieties, forty-four have been selected as the most promising ones. These are given in the following table with the principal characteristics of each. The yield given is the average of at least three years of testing.

Table No. 7 shows data for thirty-three lowland varieties and Table No. 8 for eleven varieties of upland palay. An idea of the size and shape of grains of some of these varieties may be obtained by referring to Plates XXXVI and XXXVII, which show the grains mounted on cross section paper, the heavy lines being 1 centimeter apart.

The records given in the preceding table are for the varieties selected so far by the Bureau of Agriculture and recommended for general planting. The planter is left to make his choice as to the ones that would suit his locality. It may be that future tests will put others in this list and cause some that are now there to be dropped out. Neither the earliest, which matures in one hundred and eighteen days, nor the latest, which matures in two hundred and nine days, is included in the above list of selected varieties. There seems to be very little difference in the average yield of those maturing in one hundred and forty days as compared with those maturing in one hundred

TABLE NO. 7.—*Some of the best lowland varieties*

Variety	Permanent number	Origin	Habitat[a]	Number of days from sowing to—		Yield per hectare		Physical characteristics of the grain													
								Shape		Dimension		Hispid or glabrous[d]	Color of		Thickness of hull[c]	Bearded or non-bearded[g]	Color of cuticle[h]	Head at harvesting			Flavor[j]
				Heading	Maturity	Kilos	Cavans	Outline[b]	Thickness[c]	Length	Width		Hull[e]	Tip[f]				Average length in centimeters	Shattering[i]	Average number of grains per head	
Apostol	1,001	Laguna	L	112	144	2,383	55.41	Lo	St	8.70	2.98	H	S	S	M	Nb	W	29.5	M	151	M
Bacnang	24	La Union	L	137	170	2,508.8	57.50	Le	T	8.47	2.75	H	Ds	B	T	Nb	W	28.3	Ne	184	G
Binacroy I	74	Pangasinan	L	132	166	2,800	64.20	O	M	8.72	2.91	H	Bs	B	M	B	W	31.9	Ne	271	N
Binagacay II	76	Occidental Negros	L	151	188	2,321	53.20	L	M	8.92	3.00	H	S	S	T	B	W	27.2	M	137	N
Binitoon-oldog	97	Zambales	L	120	151	2,382.7	54.60	E	M	8.20	3.28	H	S	P	Tk	Nb	W	26.6	M	151	------
Bircacoc a dalusung	108	------------	L	135	169	2,670	61.20	O	M	8.81	3.08	H	Bss	B	M	B	W	27.6	Ne	213	N
Cabantong	152	Bohol	L	108	137	2,368.6	54.32	E	Tk	7.70	3.25	H	S	S	M	Nb	W	26.6	M	155	------
Caborong	170	Antique	L	147	178	2,892.4	66.30	E	M	7.90	3.05	H	Ds	Dp	M	Nb	W	24.6	M	158	------
Calibo III	1,072	Nueva Ecija	L	133	165	3,040	69.70	O	M	8.44	3.00	H	Ds	S	Tk	Nb	W	22.3	M	137	------
Capotol	262	Bohol	L	110	140	2,574.2	59.04	O	M	7.89	3.05	H	S	S	M	Nb	----	25.4	M	164	------
Conner	1,002	Tarlac	L	110	142	2,644	61.48	E	M	8.26	3.04	H	S	S	M	Nb	W	24.5	M	214	M
Cruz	1,003	Tarlac	L	110	141	2,857	65.50	E	Fp	7.81	3.34	H	Swps	P	M	Nb	W	25.8	M	133	M
Dasol	348	Zambales	L	123	155	2,551.8	58.50	E	M	8.20	3.20	H	C	B	Tk	Nb	W	28.4	T	194	------
Dinalaga VI	1,162	------------	L	135	167	2,825	64.80	E	M	8.00	3.35	H	Bs	S	M	Nb	W	21.8	M	151	------
Grana II	396	Pangasinan	L	131	162	2,699.5	61.90	E	M	8.65	3.27	H	S	B	M	B	W	30.3	Ne	227	N
Inasimang	447	Tarlac	L	137	169	2,854	65.40	E	M	7.64	3.14	H	S	S	M	Nb	W	23.3	M	251	M
Inita	989	Tarlac	L	92	126	2,300.4	52.70	E	M	7.90	3.10	H	S	S	M	Nb	W	26.6	M	176	N
Iray	463	Nueva Ecija	L	129	160	2,438.8	55.90	E	Tk	8.13	3.28	H	S	S	M	Nb	W	23.9	M	177	------
Kinatia I	756	------------	L	152	185	2,866	65.70	E	M	7.56	3.04	H	S	S	M	Nb	W	34.5	M	264	------
Lubang-luay	519	Capiz	L	103	135	2,423.3	55.58	Obl	M	8.07	3.14	H	S	S	M	Nb	W	25.6	M	195	G
Macan I	527	Tarlac	L	147	180	2,708	62.10	E	T	8.05	3.02	H	Bs	S	M	Nb	W	22.8	L	161	------
Macan Piña	530	Tarlac	L	112	139	2,513.3	57.64	Eo	M	8.12	3.05	H	S	S	M	Nb	W	24.4	M	207	N
Macan Señora	532	Nueva Ecija	L	136	165	2,448.7	56.20	E	M	8.36	2.91	H	S	S	Tk	Nb	W	24.4	M	217	------
Manabun-ac	579	Antique	L	150	181	2,536.4	58.20	E	M	17.24	3.19	H	Bs	S	M	B	W	23.2	Ne	211	N

Ministiza	627	Nueva Ecija	L	138	179	2,287.2	52.40	L	M	0.10	2.91	H	Bs	Lb	M	Nb	W	24.9	M	273	------
Mulan-ay	635	Tarlac	L	113	143	2,704.3	62.00	E	M	7.41	3.30	H	Lb	Ds	Tk	Nb	W	25.4	L	177	------
Pauni	663	Tarlac	L	112	144	2,448.2	56.10	Se	M	8.74	3.15	H	S	S	M	Nb	W	25.8	M	145	------
Piniling Daniel	692	Tarlac	L	145	177	2,790.6	64.00	E	M	7.80	2.92	H	S	P	M	B	W	21.8	T	211	------
Roxas	1,004	Tarlac	L	110	142	2,715	63.14	Obl	M	8.51	3.16	H	Bwls	S	Tk	Nb	W	25.8	L	145	P
Saba	772	Pangasinan	L	135	172	2,538.57	58.20	Eo	M	9.03	3.14	H	S	S	M	B	W	29.9	Ne	238	F
Sinan-Fabian I	981	Nueva Ecija	L	97	130	2,343	53.70	E	M	8.81	3.26	H	S	S	M	B	W	30.7	T	144	N
Sipot	827	Laguna	L	107	138	2,660.3	61.00	Obl	M	8.06	2.80	H	Bs	Bk	M	Nb	W	22.5	L	143	------
Tarbayanon II	860	Misamis	L	110	144	2,474.2	56.70	Eo	M	8.03	2.86	H	Bs	S	Tk	Nb	W	28.1	M	209	------

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[a] L= Lowland. [b] E= Elliptical; Eo= Elliptic oblong; L= Linear; Le= Linear elliptic; Lo= Linear oblong; O= Oblong; Obl= Oblanceolate; Se= Slightly elliptic. [c] Fp= Fairly plump; M= Medium; St= Somewhat thick; T= Thin; Tk= Thick. [d] H= Hispid. [e] C= Chestnut; Swps= Straw with purplish shade; Bs= Brownish straw; Bss= Brown straw stripes; Bwls= Brown with light stripes; Ds= Dark straw; Lb= Light brown; S= Straw. [f] B= Brown; Bk= Black; Dp= Dark purple; Ds= Deep straw; Lb= Light brown; P= Purple or purplish; S= Straw. [g] B= Bearded; Nb= Non-bearded. [h] W= White. [i] L= Loose; M= Medium; Ne= Not easy; T= Tight. [j] G= Good; F= Fair; N= Non-aromatic; M= Medium; P= Plain.

TABLE NO. 8.—*Some of the best upland varieties*

Variety	Permanent number	Origin	Habitat [a]	Number of days from sowing to—		Yield per hectare		Physical characteristics of the grain													
								Shape		Dimension			Color of—					Head at harvesting			Cooking quality	
				Heading	Maturity	Kilos	Cavans	Outline [b]	Thickness [c]	Length	Width	Hispid or glabrous [d]	Hull [e]	Tip [f]	Thickness of hull [g]	Bearded or non-bearded [h]	Color of cuticle [i]	Average length in centimeters	Shattering [j]	Average number of grains per head	Taste [k]	Aroma [l]
Bagonhon II	900	Batangas	Up	108	137	2,210	50.70	E	M	6.97	2.85	Sh	S	B	T	Nb	W	26.9	M	279	-----	-----
Binicol I	92	Laguna	Dp	103	141	1,699.7	38.98	E	Tk	6.90	3.40	H	Ls	S	T	Nb	A	28.8	M	218	Vg	A
Catalong	945	Oriental Negros	Up	103	143	2,431.2	55.76	E	M	8.12	3.18	H	Ys	Lb	M	Nb	W	26.3	M	199	M	Sa
Dinagat I	362	Laguna	Dp	87	123	1,904	43.67	O	M	7.63	3.01	H	Ls	S	M	Nb	W	26.3	M	159	M	-----
Inantipolo II	956	Cavite	Up	107	138	2,378.75	54.55	E	M	7.05	3.05	G	S	Pb	M	Nb	W	22.3	T	216	Vg	A
Kinandang Puti II	952	Batangas	Up	79	106	2,883	66.01	E	M	7.41	3.02	H	S	S	Tk	Nb	W	24.7	M	185	M	Na
Kinastila IV	639	Tayabas	Up	104	130	2,696.3	61.84	E	M	7.40	2.47	Sh	Rbs	Ls	M	Nb	W	-----	-----	-----	G	Sa
Nagdami	980	Alabang	Up	95	128	1,939	44.47	Ro	Tk	8.02	3.61	Sh	Ds	C	M	Nb	W	25.7	Me	178	-----	-----
Nagsaya	642	Batangas	Up	98	136	2,287.7	52.47	E	T	7.35	3.05	H	S	S	M	Nb	W	20.2	M	295	-----	-----
Pulupot	718	Tayabas	Up	106	138	1,952	44.77	E	M	7.00	3.05	G	S	B	M	Nb	W	21.6	M	330	Vg	A
Saloot	784	Batangas	Up	108	148	2,435	55.84	Ov	Tk	6.87	3.35	H	Dbsr	Db	Tk	Nb	W	23.7	M	277	-----	-----

[a] Dp= Dual purpose; Up= Upland.

[b] E= Elliptical; O= Ovate; Ov= Oval; Ro= Rather oblong.

[c] M= Medium; T= Thin; Tk= Thick.

[d] G= Glabrous; H=Hispid; Sh= Somewhat hispid.

[e] Ds= Dark straw; Dbsr= Dark brown straw ridges; Ls= Light straw; Rbs= Reddish brown stripes; S= Straw; Ys= Yellowish straw.

[f] B= Brown; C= Chocolate; Db= Dark brown; Lb= Light brown; Ls= Light straw; Pb=Purplish brown; S= Straw.

[g] T= Thin; Tk= Thick; M= Medium.

[h] Nb= Non-bearded.

[i] A= Amber; W= White.

[i] A= Amber; W= White.

[j] M= Medium; Me= Medium easy; T= Tight.

[k] G= Good; M= Medium; Vg= Very good.

[l] A= Aromatic; Na= Non-aromatic; Sa= Slightly aromatic.

Nursery seedbeds for the head-to-the-row test culture, Alabang Central Rice Breeding Station

A portion of the testing fields, Alabang Central Rice Breeding Station, showing the rows planted with seeds from selected mother plants. Preliminary feature of pedigree work and eighty-six days. Except for timing the planting and harvesting to profit by the average weather conditions there is no reason for growing a variety that requires more than one hundred and fifty days to mature. The Apostol, or what was originally known as the "Señora II," is one of the best varieties of this class found so far.

THE UPLAND VARIETIES

Four hundred and thirty-one upland varieties have been tested in the Lamao and La Carlota Experiment Stations. The ground where the tests were made was cleaned of brush and prepared in the usual way for upland rice. The varieties were planted in duplicate plots of the same size as for the lowland.

Table No. 8 shows the data for the eleven highest yielding varieties of upland rice that are to be recommended for general upland planting. Plate XXXVII shows the size and shape of the grains of some of these varieties.

HEAD-TO-THE-ROW TEST

From the forty-four most promising varieties selected in the variety test, seven have already been improved by means of the head-to-the-row test culture. These varieties are given in Table No. 9. The remainder are still being experimented upon. Pure strains of these varieties have been isolated, propagated and the seed produced therefrom distributed all over the Philippines. About three hundred cavans of pedigreed seed is produced every year from the stations of the Bureau of Agriculture for distribution to the farmers.

Table No. 9 gives the characteristics of, and some other information concerning these pedigreed seeds.

The isolation of a pure strain through the head-to-the-row test culture is a complicated experiment, as it takes at least three years of experimentation to produce pure strained seed.

The experiment was carried on as follows: The above varieties were numbered from one to seven. About 25 heads of the so-called mother plants were separated into five stocks and the heads of each stock were also numbered from 1–1 to 1–25 for variety No. 1; and 2–1 to 2–25 for variety No. 2, etc. Then each of these heads was planted in a separate seedbed, as for the variety test, as shown in Plate XXXVIII, and 100 seedlings or whatever number of seedlings there were, in rows numbered Row No. 1–1 and head number 2 in Row No. 1–2 and so on. The rows were marked with either bamboo or wooden stakes with the number written in oil paint. Of the 25 heads selected from the mother plants, the first stock numbered head No. 1–1 to 1–5 inclusive and second stock head No. 1–6 to 1–10 inclusive

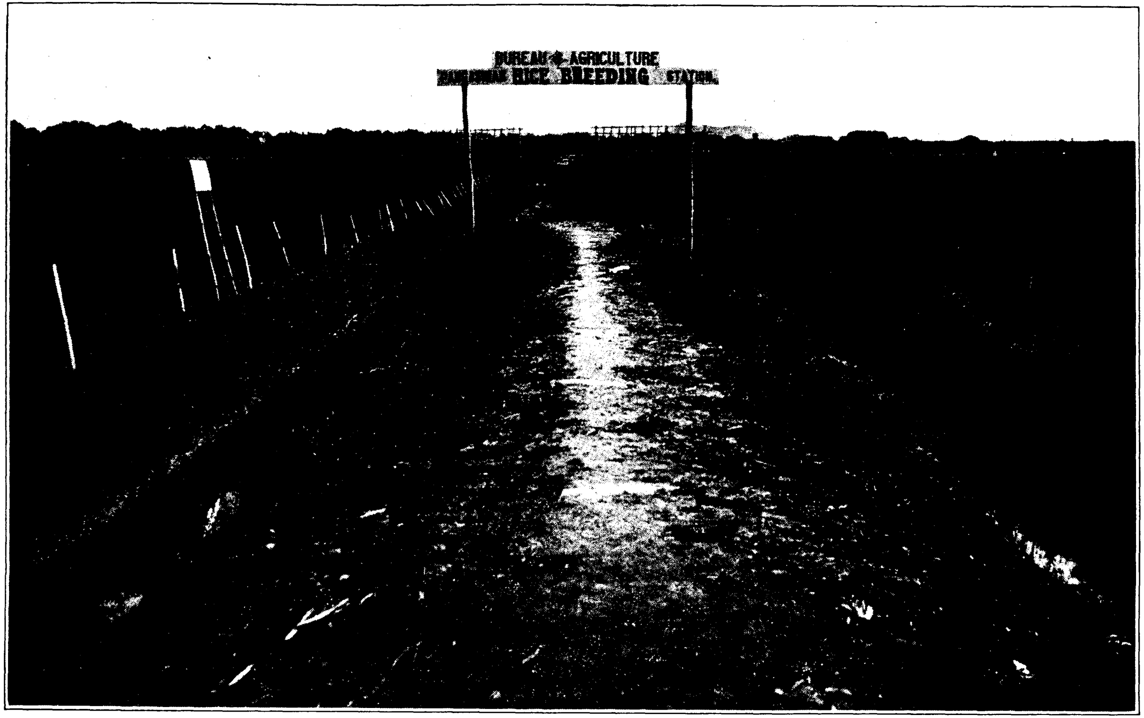
TABLE No. 9

Variety	Permanent number	Origin	Habitat [a]	Age at maturity	Yield per hectare		Degree of popular acceptance [b]	Physical characteristics of the grain										
								Shape		Dimension		Hispid or glabrous [e]	Color of—		Thickness of hull [h]	Bearded or non-bearded [i]	Color of cuticle	Flavor [k]
								Outline [c]	Thickness [d]	Length	Width		Hull [f]	Tip [g]				
				Days	*Kilos*	*Cavans*												
Roxas	1,004	Tarlac	L	142	2,715	63.14	M	Obl	M	8.51	3.16	H	Bwls	S	T	Nb	W	P
Cruz	1,003	do	L	141	2,857	65.50	M	E	Fp	7.81	3.34	H	Swps	P	M	Nb	W	M
Apostol	1,001	Laguna	L	144	2,383	55.41	H	Lo	St	8.70	2.98	H	S	S	M	Nb	W	G
Conner	1,002	Tarlac	L	142	2,644	61.48	M	E	M	8.26	3.04	H	S	S	M	Nb	W	M
Macan I	527	do	L	180	2,708	62.10	H	E	M	8.05	3.02	H	S	S	M	Nb	W	G
Inasimang	447	do	L	170	2,854	65.40	M	E	M	7.64	3.14	H	S	S	M	Nb	W	M
Piniling Daniel	692	do	L	177	2,790.6	64.06	M	E	M	7.83	2.96	H	S	S	M	Nb	W	M
Inantipolo II	956	Cavite	Up	138	2,378.8	54.55	H	E	M	7.05	3.05	G	S	Pb	M	Nb	W	Vg

NOTE.—All the above varieties are non-glutinous, non-bearded rice.

[a] Dp= Dual purpose; L= Lowland; Up= Upland
[b] H=High; M= Medium
[c] E= Elliptical; Lo= Linear oblong; Obl= Oblanceolate
[d] Fp= Fairly plump; M= Medium
[e] G= Glabrous; H= Hispid; Sh= Somewhat hispid
[f] Bwls= Brown with light stripes; S= Straw; Swps= Straw with purplish shade
[g] Ls= Light straw; S= Straw; P= Purplish; Pb= Purplish brown
[h] M= Medium; T= Thick
[i] Nb= Non-bearded
[j] W= White
[k] G= Good; P= Plain; M= Medium; Vg= Very good

A view of the glutinous variety "Bulastog," Perm. No. 1069, in the head-to-the-row test culture, Alabang Central Rice Breeding Station



A view of the main road of the Pangasinan Rice Sub-station and so on. Only one seedling was planted in each hill, 20 centimeters spaces being left between each row and 20 centimeters between hills in the row. (See Plate XXXIX.) As a rule outside rows are apparently more favorably located than the interior ones because they received more sunlight and plant food. For this reason an extra three rows of plants were planted first before Row No. 1 was begun. To give each stock as uniform conditions as possible so that a fair comparison could be made, the most uniform soil was selected for this experiment.

Careful observations were made during the development of the plants as to the time of heading and maturity and tendency to lodge of each row and these were used to serve as a guide in selecting the most promising row or individual plant for further improvement. The height of the plants was measured, and the number of nodes, bearing culms and white heads of each plant counted to find out the average per plant in each individual row. (See Plate XL.)

Before harvesting, the heads of each plant having six or more good heads were tied together with bamboo strips, and then labeled properly with the number of the row and the number of the plant in the row. Plants having six or more good heads were termed *good plants* and those below *poor plants*. Then the plants of each row were cut and tied together in a bundle and labeled with the number of the row.

A. Before threshing, fifty heads from each bundle were picked at random but uniformly about 1 centimeter below the base of the panicle. The grain was weighed and the weight noted.

B. After picking the fifty heads, the good plants (those tied up plants having 6 or more heads) were separated from the poor ones or those plants having less than six heads. The heads of each group were picked and the two groups *good* and *poor* were weighed separately, taking care that the *heads* of each of the *good* plants were tied together by themselves and carefully labeled, with the corresponding plant number. The weight of each group was noted down.

C. The three weights were added together to find the yield by weight per row. The total weight was noted.

D. The length of each of the fifty heads in A, was measured and the total divided by 50 to find the average length of heads per row.

E. Ten heads of average size, as determined in D, were put in an envelope and used to determine the average number of spikelets and grains in the heads of every row. The envelope was labeled carefully with the corresponding row number.

F. The remaining forty heads were then mixed and threshed with the heads of the *poor* group.

G. The heads of the *good* group were left intact until the best five rows of the best stock were determined and the 25 heads desirable to reserve were selected and separated therefrom. These heads were kept for further selection.

H. After this was done (see G), all the remaining heads of the different plants of the *good* group of the *first choice stock* were mixed and threshed. The grain was cleaned well, and carefully stored in a properly labeled sack.

I. The same was done with the heads of the *good* group of the *second choice stock,* except that it was not necessary to first select and separate 100 heads.

J. All heads of the *good groups* of the three other stocks of each variety were mixed and threshed together, and each was labeled properly.

K. The grains of all the *poor groups* of each variety were put together, except those of the first and second choice groups, respectively, which were sacked and carefully labeled and stored separately. Knowing the number of hills in the row and the number of white heads, the theoretical yield per hectare of a 100 per cent stand was calculated, so that a fair comparison between each row and each stock was made.

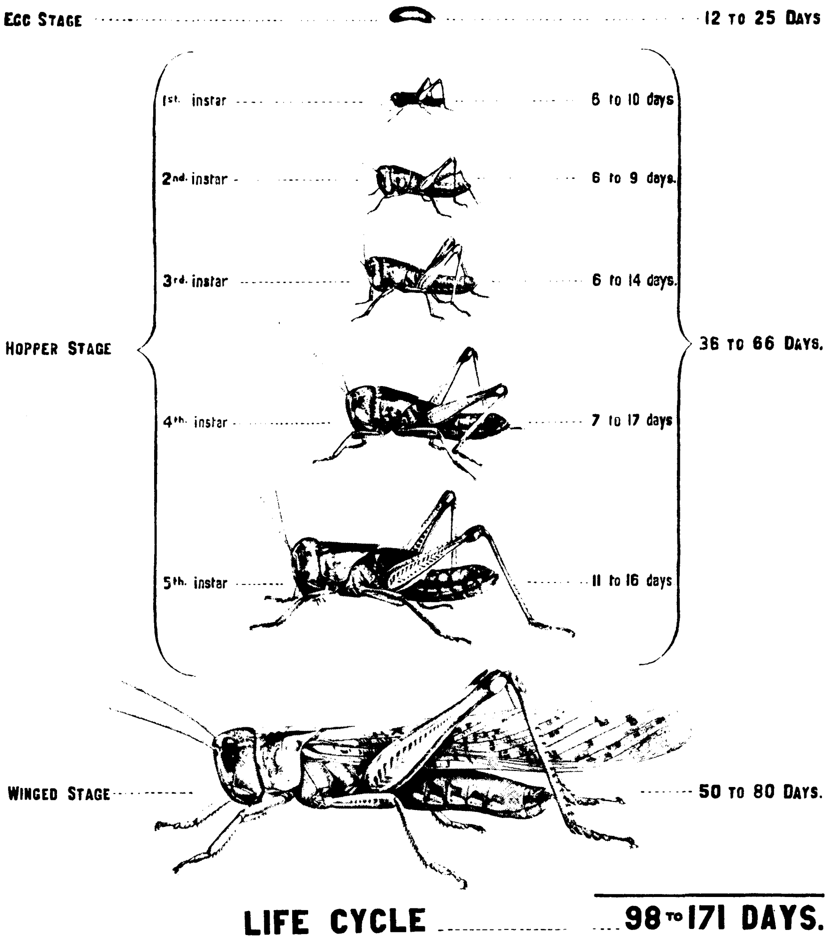
The same was done with the second choice stock, which was used as reserve seed in case the first choice might be damaged.

By comparing the yield and number of desirable heads of each plant the five best rows or the best stock were determined. The heads of each good plant of these selected rows were laid on a table and about 10 of the largest heads having the largest number of grains were selected from each row and these were kept hanging inside of a bag with moth balls until the next planting.

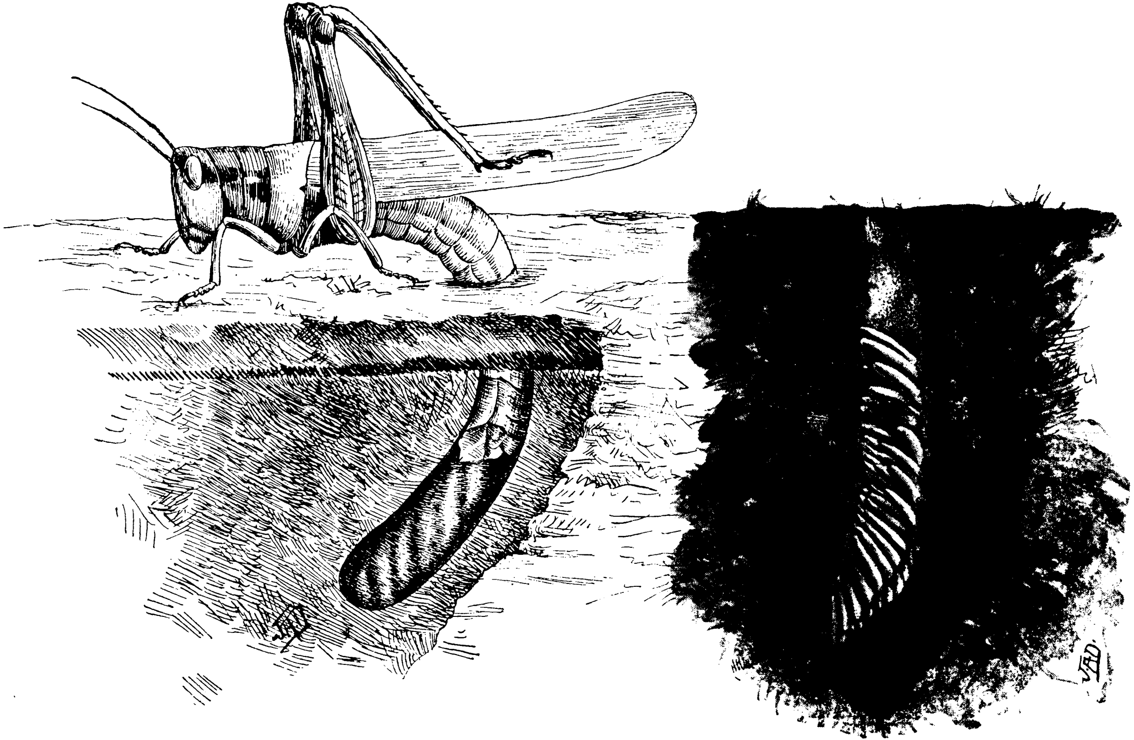
This experiment was made for at least three successive years before conclusions as to the seven varieties were drawn, by which time the strain of the variety tested had become greatly improved. Then this was propagated and the seed produced therefrom pronounced pedigreed seed.

ADAPTION TO LOCALITY

No matter how much seed palay is improved, when planted in some other province having different climatic conditions than



Life history of migratory locust



Migratory locust depositing eggs, and eggs layed in soil the place where it has been grown, it does not give the result expected, as its yield is affected more by the local climatic than soil conditions. For this reason *seed for distribution in any particular region of the Philippines must be improved and produced where it is to be grown.*

Therefore the *establishment of rice sub-stations* in a number of places in the Islands *to develop the best variety for different regions* and to propagate enough seed of same for distribution seems to the writer the best method of permanently increasing the present production of rice. These stations would also serve as places to *study* and *demonstrate* the *best methods of raising rice under local conditions.*

Only one station of this kind has been established so far by the Bureau of Agriculture, that in Rosales, Pangasinan; but every effort is being made to establish more stations in order that a considerable quantity of improved seed adapted to local conditions for distribution to farmers can be produced. (See Plate XLI.)

The *importance of selected varieties in increasing the present production* has been repeatedly explained, as results from the Alabang Central Rice Breeding Station show that the average yield per hectare at present of 25 cavans can be easily raised to at least 40 cavans by using selected seed, *although the conditions there are not favorable to the production of this cereal.* So even at this rate of production, if all the rice farmers in the Islands would only plant seed of *selected varieties adapted to local conditions,* it is believed that even without increasing the present area planted to this crop the Philippines would produce enough rice to feed its inhabitants. And obviously the better the soil and climatic conditions the higher this rate of increase would mount.

RICE PESTS *

Pests and diseases of annual crops are considered of minor importance in most modern countries. This is due to the fact that most pests and diseases are easily controlled by crop rotation, clean culture, and systematic planting. But here in the Philippines, where intensive agriculture is not yet practiced, pests and diseases are important. Were the farmers able to cultivate all grass lands in the Philippines or, reforest or afforest them, and if crop rotation were practiced throughout the Archipelago so that no weeds could grow; and *if the beneficial birds were not so nearly extinct,* locusts, cutworms, rice bugs, rats, etc., would be fairly negligible factors in our agricultural undertakings.

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* Contributed by ARSENIO GOCO, *Plant Inspector,* Plant Pests Control Division.

But as conditions are not satisfactory in these respects, control measures must be taken.

RATS

Rats are sometimes very destructive in places, especially near uncultivated lands where they hide and breed when rice is harvested. To control this pest economically, therefore, it is necessary to destroy the hiding places. The cogon should be set on fire to kill them. The small undergrowth of any nearby forest should be removed, as it furnishes a harborage. Thus the rats will be deprived of protection; they will be exposed to severe weather and natural enemies. So that too great loss may be prevented, the hiding places around the fields should be cleaned out or burnt off before any crop is planted.

When the rats are already in a rice or cane field, poisoning and trapping will be found necessary. For this purpose several poisons are used. White arsenic gives good results when applied in the field. If it is necessary to use this near where there are domestic animals the poisoned bait should be placed in containers such as bamboo tubes, so that animals other than rats will not be poisoned. For house rats, barium carbonate is recommended as the rats seek water after eating the bait and if there is no water left in the house where they can have access to it they will go in search of it and die outside.

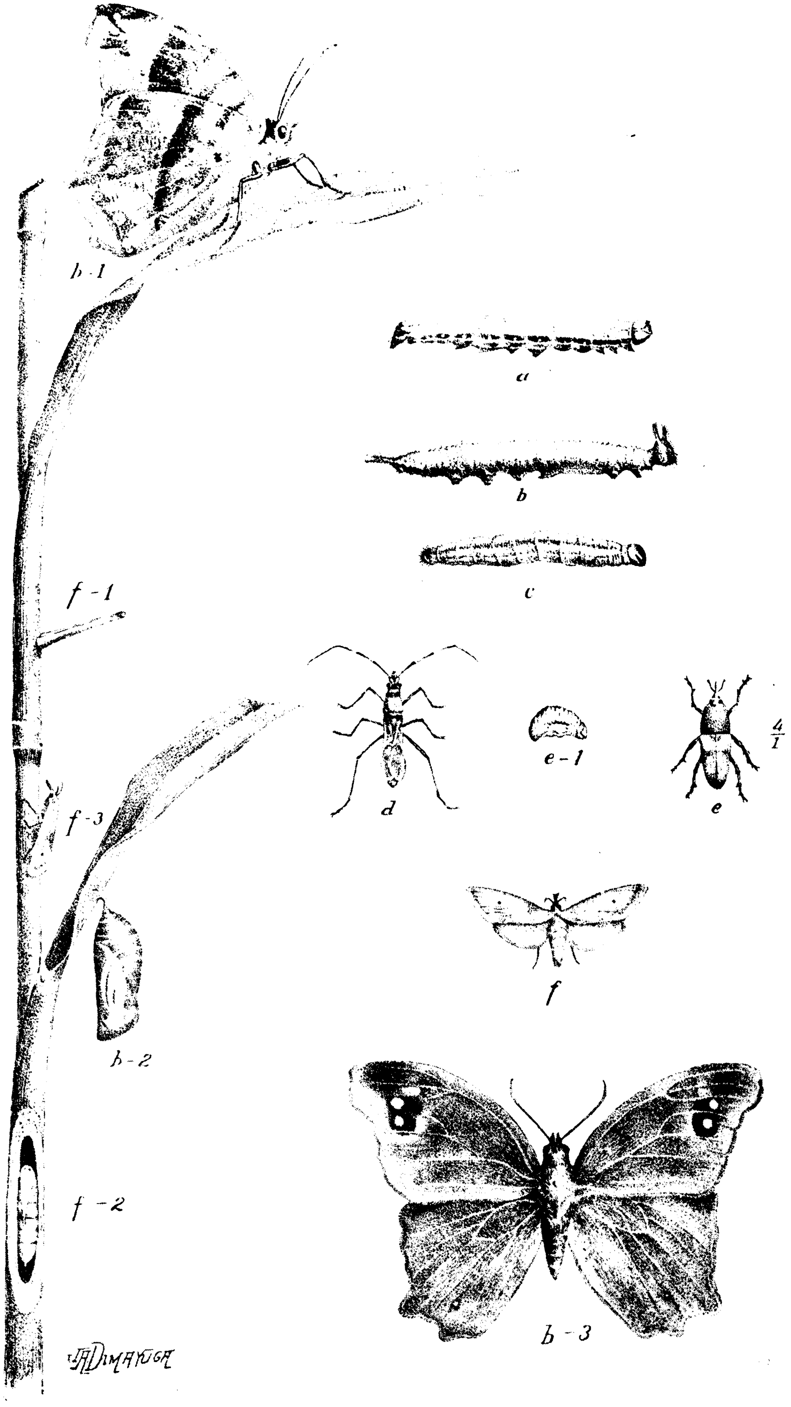
When arsenic becomes ineffective other poisons, such as strychnine sulphate, should be substituted. This is necessary because rats become resistant to arsenic when they have consumed this poison little by little for some time.

In using white arsenic, one part of it is mixed with 5 to 10 parts of any rat food. The more watery the food is the less poison need be used. In case strychnine sulphate is to be used, the proportion is one of strychnine to 20 or 25 parts of rat food, etc.

BIRDS

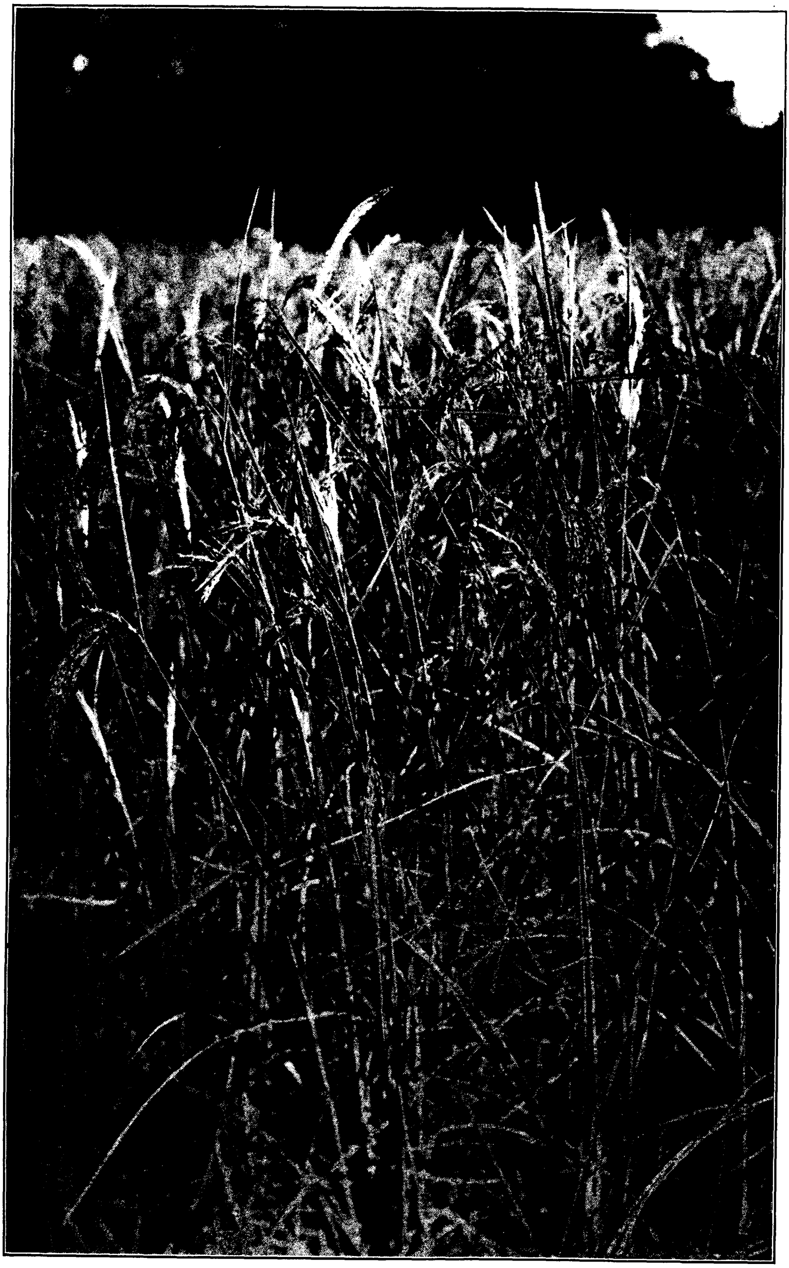
Birds known locally as "Mayang pula" (*Munia jagori* Martens), "Mayang paking" (*Uroloncha everitti* Tweed) and "Mayang costa" (*Munia oryzivora* L.) are sometimes destructive. The last are not very common. Only the Mayang paking and Mayang pula are very destructive. They may live in flocks together and may not.

Control measures.—In many places these birds are welcomed by farmers because they catch them for food, while in some places they are held as enemies. In places where they are considered destructive the people detail some one to scare them away nearly all day. This method is not considered effective as it only drives the birds to some other field, and sometimes they become so



Insects destructive to rice plants

a, *Spodoptera maurita* Boisd., full-grown caterpillar. *b*, *Melanitis ismene* Cram., larva; b-1, butterfly at rest; b-2, pupa; b-3, imago, wings spread. *c*, Unidentified Hesperid caterpillar. *d*, *Leptocorisa acuta* Gem., imago. *e*, *Calandra oryzæ* L., imago; e-1, larva. *f*, *Schœnobius punctellus* Zell., imago; f-1, leaf-case of larva; f-2, pupa, inside of rice stalk; f-3, imago at rest.



White heads caused by stem borer (*Schœnobius punctellus*, Zell.)

accustomed to being scared that they alight in spite of the efforts of the man detailed for the work. The methods of catching "maya" are as follows:

1. Ficus gum is obtained and this is daubed on several sticks. These sticks are then placed on a pole in the form of a leafless plant. The pole is then placed where the mayas usually alight. As they usually alight first on some available stand before feeding, the sticky stand catches them. Sometimes a maya is tied to a pole to attract other birds. This is said to add to the effectiveness of the trap.
2. Other methods of catching these birds is to set a net trap. The net is placed on a square frame one side of which is fastened to the ground and the opposite side lifted with a long string to be loosened when the birds go under the net after the bait.
3. In places where there are resting places for them a man goes with a hand net and sweeps them up at night. This method is the easiest when the resting place is easily accessible.

INSECTS

There are very few insects that destroy rice in comparison to the number that attack other crops but unfortunately these insects have adapted themselves to living on other plants, so that they are able to multiply in the absence of rice. Due to this fact a study of the different hosts of these insects is very important in order to control them by systematic planting, etc.

One of the most important insect pests of rice is the migratory locust, the life history of which is illustrated in Plate XLII. The only remedy for this pest is to destroy the hoppers by driving them into pits.

It is believed that the reforestation of open grass lands in the Philippines which are not used would be a permanent control measure for locusts. Besides preventing locusts, it would prevent floods, regulate the water supply and increase the soil fertility by supplying rotten leaves, twigs and animal life. Much money would be needed to effect this but the benefit derived would be incalculable. (See Plate XLIII.)

Another very destructive insect is the rice bug (*Leptocorisa acuta*) locally known as "Atangia" in Tagalog; "Tiangao" in Visayan; "Dangeo" or "Dangueo" in Pangasinan; and "Dangao" in Zambales which is considered by Mr. L. B. Uichanco of the College of Agriculture, University of the Philippines, to be more destructive than the locust. This is true, as locusts are not destructive all the time, while the atangia is ever present in most fields. (See Plate XLIV-*d.*) Many control measures have been suggested. Of these systematic crop rotation or clean culture can be considered the best. Next to this is the selection of resistant varieties, but it should be taken into consideration that adaptation usually goes on in nature. In order to practice rotation profitably it should be considered that the rice bug feeds on several kinds of Panicum, one kind of Digitaria, Eleusine, Andropagon, Paspalum and Seterine, etc.

To kill these, putrifying meat can be placed in bags as bait, for the adult bugs are attracted by its odor. The bugs thus attracted are either burned by a torch, or caught with nets.

It is also suggested that small patches of some early varieties of rice be planted in the infested fields with the object of burning the whole when most of the bugs in the place are concentrated in the trap patches.

Another very effective method of preventing much loss is to plant varieties of palay maturing at the same time in each locality. This suggestion may be objectionable to those farmers who harvest their palay head by head with the use of the "yatab" as previously described, for the process is so slow that there will not be enough hands for the work when all the palay in a locality matures at the same time.

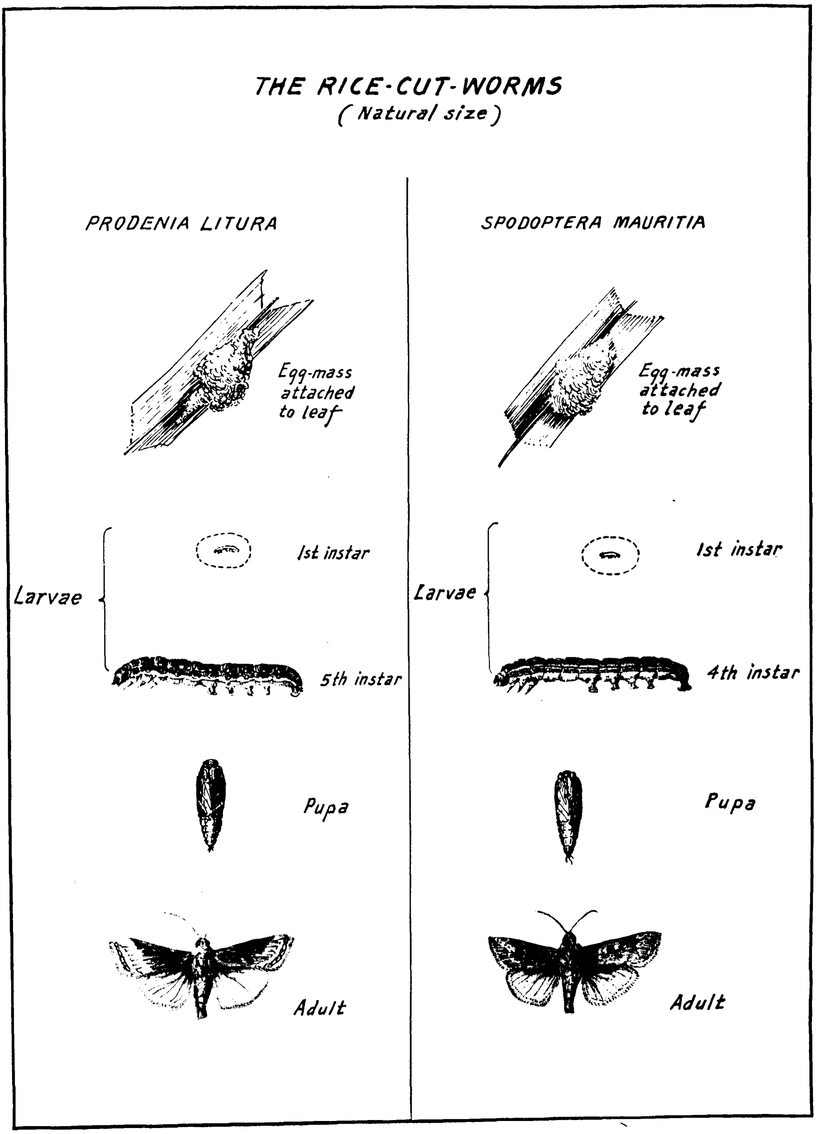
In this case the harvesting with the sickle or "lingcao" as practiced in Central Luzon for lawland palay is recommended, as this is a faster method than the one just described.

The planting of varieties of rice which ripen almost simultaneously will not only prevent losses due to the rice bug but also to certain birds and other animals that destroy the grain.

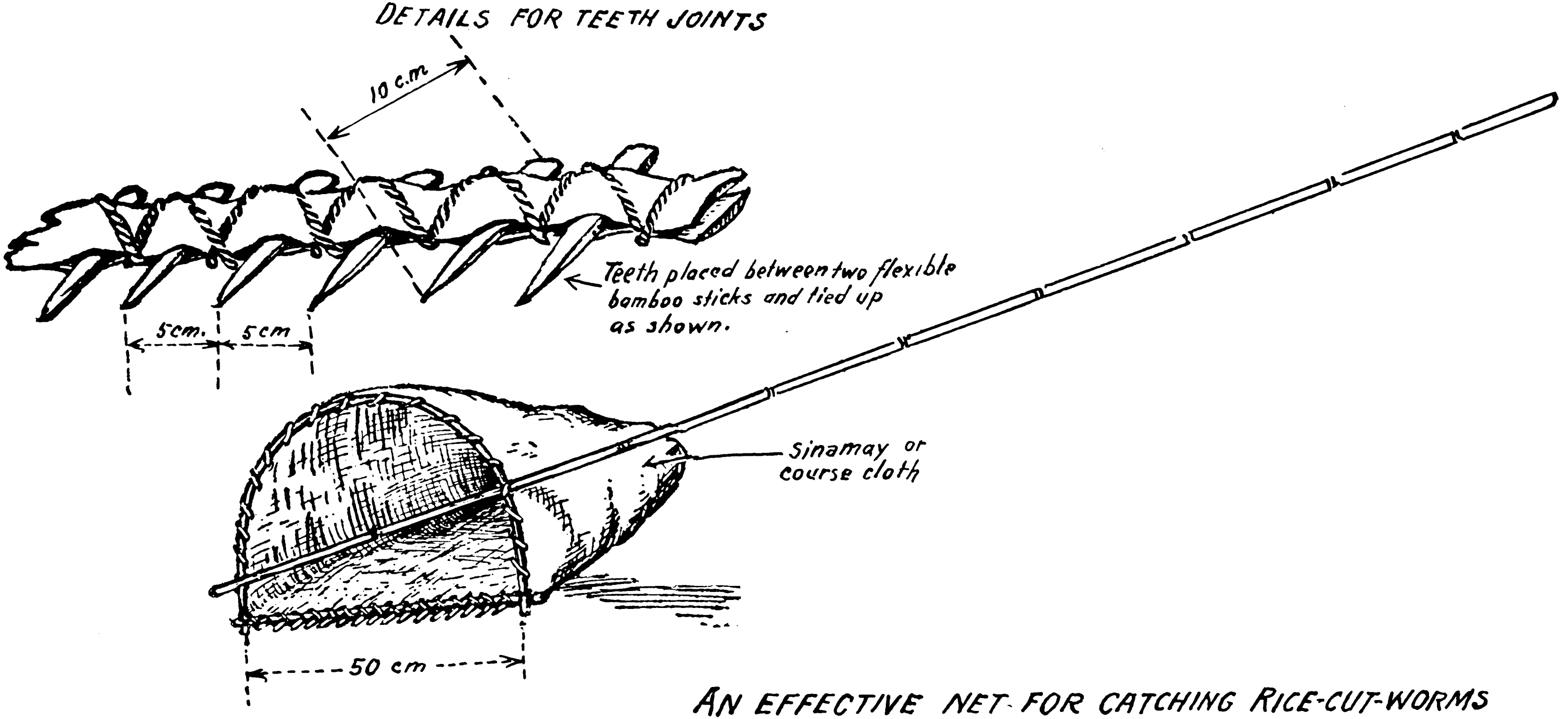
The rice stem-borer is sometimes very abundant and causes great damage. This borer is reported by some writers to be *Schoenobius punctellus* Zell. Rice plants attacked by this pest produce empty, bleached grains, as shown in Plate XLV. A dipterous parasite has been observed and this may be the reason why this pest is not very widespread.

It is believed the rice stem-borer lives on wild grasses, as it is impossible for the adult to live long enough to lay eggs during the next rice season, which is about six months later. For this reason clean culture as suggested for the rice bugs and other insects will also control this pest.

Rice leaf insects.—Of the lepidopterous insects that attack the leaves of rice two leaf folders are very important. One of these is a butterfly known as *Melanitis ismeni* Cram, shown in Plate XLIV-*b*. It lives in folded leaves and eats from their ends. Although this pest is well distributed, especially in places where continuous planting of rice is practiced through the help of irrigation, it cannot be classed as a serious pest due to the Braconid



Life history of rice-cut-worm


DETAILS FOR TEETH JOINTS
10 c.m
5cm.
5cm
Teeth placed between two flexible bamboo sticks and tied up as shown.
Sinamay or course cloth
50 cm

AN EFFECTIVE NET FOR CATCHING RICE-CUT-WORMS parasite which controls it. Besides this it is believed that it can live only on very few kinds of grass so that it will not multiply rapidly. The other lepidopterous pest is the small moth known as *Cnapalocrosis medinales*. The larva of this also lives in a folded leaf, but it does not cut the leaf; it only strips the upper surface so that the leaf turns white and dry afterwards.

When the writer was rearing some of these pests, several parasitic and predaceous insects were observed keeping them under control. The outbreaks are therefore only periodical.

Some varieties of rice seem to be more susceptible to attacks than others.

Rice cut-worms or army worms (Plate XLVI) are caterpillars of two kinds of moths known as *Prodenia litura* Fabr., and *Spodoptera mauritia* Boisd. The caterpillars of *P. litura* are dark in color, while that of the *S. mauritia* are greenish in color.

As these pests are very abundant during the time that there is a scarcity of rain, they are seldom counted as pests of rice. When they become pests they usually commit their depredations on seedbeds, and often lay their eggs there before migrating.

In case these pests migrate a ditch about a decimeter deep and wide with steep sides is constructed into which the migrating worms will fall and be unable to climb out of. When they are found in a meadow a roller is sometimes an effective instrument to kill them in great numbers. When the eggs are laid in rice seedbeds, collecting egg-masses which are laid on the upper surface of the leaves has been found practicable. But when the eggs are hatched already it becomes necessary to sweep the seedlings with an insect net, as shown in Plate XLVII. Poisoned bran mash [1] has also shown good results when the larvae are so large that they hide in the soil and thrash during the day. For the small larvae which stay under the leaves most of the time, encouraging the ants to live in the seedbed will be of use when practicable, as in some parts of Zambales, but these should be driven out when the seedlings are to be transplanted, by scattering flask naphthaline. Flooding whenever a water supply is available is the easiest and probably most effective method but this is not much practiced as yet.

A certain tachinid fly is said to parasitize on the cut-worms. To prevent too much damage the beneficial fly that controls this pest should receive consideration. This is easily done by planting different kinds of fruit trees in a community, so that the adult parasites will have a constant supply of nectar, especially during a drought. Where the welfare of this beneficial insect is carelessly neglected, an outbreak of cut worms during or after severe drought is a very common result due to the inability of the controlling insects to continue their multiplication, as the grasses and weeds on which they depend for nectar die out.

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[1] *Poisoned bran mash:* Rice bran 20 parts, brown sugar or molasses 4 parts, white arsenic 1 part or Paris green 2 parts; water to dissolve the sugar and moisten the mash.

The other more important methods of control for these pests are crop rotation and clean culture, which will diminish their numbers, as is the case with other insects.

TABLE NO. 10.—*List of different varieties of rice*

[Including 1919 data]

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
1052	Abo	l-wh-ng-b	Pangasinan	150	4	2,217.10	
1	Agabon	u-wh-ng-nb	Laguna	144	1	550.00	Same as Guyud
2	Agoyor I	u-wh-ng-nb	Batangas	119	3	1,062.00	Same as Kinandang-puti
1000	Agoyor II	u-wh-ng-nb	do				
3	Aguyod		do				
4	Alaminos	l-wh-ng-b	Tarlac	193	4	1,823.00	
5	Alegria	u-wh-ng-nb	Albay	136	2	2,905.00	
6	Alemania	u	Antique				
7	Alfonsino	l-wh-ng-b		166	3	1,344.00	
8	Alibangnon	u-wh-ng-nb		143	4	1,739.00	Same as Loma
9	Alibasa	l-wh-ng-nb	Occidental Negros	127	6	1,446.00	
1053	Almisqui	wh-ng-b	Pangasinan				Same as Binalayang, Sampurado and Bakal
10	Amarillo I	u-wh-ng-nb	do	140	2	1,839.00	Same as Tabucanon II
11	Amarillo II	l-wh-ng-nb	do	146	6	2,207.00	
12	Amayan	l-wh-ng-nb	Camarines	127	3	1,459.00	
13	Ambabaay	l-wh-ng-nb	Zambales	169	2	2,680.00	
14	Amimit	wh-ng-nb					
15	Amusco	l-wh-ng-nb	Antiqne	178	2	2,357.00	
1196	Angori	l-wh-g-nb	Pangasinan	143	2	1,860.00	
16	Animas	u-wh-ng-nb		139	2	2,128.00	
994	Antique	wh-ng-nb	Occidental Negros	145	5	3,018.00	
1001	Apostol	l-wh-ng-nb	Bureau	144	2	2,283.00	
17	Arabon	l-wh-ng-nb	Cebu	184	3	2,066.00	
18	Arcupal	l-r-ng-nb	Zambales	186	3	1,617.00	
19	Aribongbon	l-wh-ng-nb	Tarlac	136	7	1,853.00	
20	Aringay	l-r-ng-b	Zambales	189	4	1,487.00	
1281	Autumn Crop		China	95	1	721.30	
21	Azucena I	l-wh-ng-b	Bulacan	167	3	2,036.00	
1054	Azucena II	l-wh-ng-nb	Nueva Ecija	177	4	4,912.00	
1192	Azucena III	l-wh-ng-nb	do	183	1	1,938.00	
1197	Baay		Ilocos Norte	210	2	219.00	
1055	Bakal	l-wh-ng-nb	Pangasinan	188	4	2,023.00	Same as Binalayang, Sampurado and Almisqui
22	Bacao	l-r-ng-nb	Albay	179	1	1,167.00	
23	Bacao bajo	l-wh-ng-nb	do	165	6	2,094.00	
24	Bacnang	l-wh-ng-b	La Union	170	6	2,508.80	
25	Bacnotan	l-wh-ng-b	Pangasinan	181	4	1,793.00	Same as Grana sabutan
1198	Bacong		Ilocos Norte	210	1	1,847.00	
26	Bacras	u-wh-ng-nb	Occidental Negros	139	1	2,870.00	
27	Bad-as	wh-ng-nb	do	183	11	2,679.00	
28	Bagonhon I	u-r-ng-nb	Antique	142			
900	Bagonhon II	u-wh-ng-nb		137	3	2,590.60	
1149	Bagsang	l-ng	Nueva Ecija	142	3	3,123.33	
29	Balagadan	l-wh-ng-nb	Camarines	155	1	1,142.00	
30	Balam	u-r-ng-nb	Laguna	127	2	3,862.00	Same as Binarit III, Bulagsac I and Lubang I
31	Balangen	l-wh-ng-b	Zambales	183	3	1,936.00	
32	Balasang I	l-wh-ng-nb	Tarlac	176	7	2,087.00	Same as Santo Niño II

TABLE No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
1199	Balasang II	u	Ilocos Norte	216	1	488.00	
33	Balayad purao	l-wh-ng-b	Pangasinan	193	4	2,021.00	
34	Balayangnon	u-wh-g-nb	Capiz	134	1	2,563.00	
35	Balibod	u-wh-ng-nb	Camarines	136	5	2,090.00	Same as Libod and Nagsanoot
36	Baliw	l-wh-ng-b		166	8	2,486.00	Same as Cusimay Buric and Binacroy I
37	Baliuag	l-wh-g-b	Pangasinan	191	4	2,063.00	
38	Balodnon	u-wh-ng-nb	Cebu	127	2	1,729.00	
1056	Bal-latinao	bl-g-b	Pangasinan	175	4	3,199.00	
1012	Bal-logo	wh-ng-nb		164	1	2,000.00	
1057	Balolaki I	l-wh-ng-b	do	176	4	2,031.00	Same as Daluson a biit, Dinaluson, Sinan-Fabian II and Binacroy II
1153	Balolaki II	l-ng-b	Nueva Ecija	176	3	1,715.00	
39	Balolaki-pula	l-wh-ng-b	Pangasinan	179	4	1,916.00	
1150	Balsang	l-wh-ng-b	Nueva Ecija	128	3	1,535.00	
1058	Banata	l-wh-ng-b	Pangasinan	198	3	2,370.00	
40	Bandra a bayag	l-wh-ng-b		173	3	1,918.00	
41	Bangbang-pula	l-r-ng-nb	Camarines	212	1	417.00	
42	Bangbang-puti	l-r-ng-nb	do	218	1	186.00	
43	Banglam	l-wh-ng-nb	Iloilo	138	5	1,203.00	
44	Banla I		Tarlac				Same as Malines and Pinirot
1059	Banla II	l-wh-ng-b	do	172	4	2,371.00	Same as Mendoran
1152	Bangol		Nueva Ecija	140	3	1,836.33	
1061	Bangol or Saigorot	u	Pangasinan				
1060	Bansuroy I or Disal	l-wh-ng-b	do	164	4	2,449.00	Same as Kinaturay
1151	Bansuroy II	ng	Nueva Ecija	169	1	3,025.00	
985	Bakiaw	wh-ng-nb	Laguna	143	5	2,366.00	
45	Baquet	l-wh-g-b	Pangasinan	190	4	1,411.00	
46	Baranay	u-wh-ng-nb	Camarines	164	2	2,129.00	Same as Binagacay I
47	Barangcal	l-wh-ng-nb	Antique	131	13	2,203.00	Same as Capotol
48	Barog	l-wh-ng-b	Tarlac	195	4	1,775.00	Same as Binacal
49	Barotak	l-r-g-b	Sorsogon	172	1	1,000.00	
50	Barsañga	l-wh-ng-b	Tarlac	175	3	1,888.00	Same as Sampurin
51	Bascalan	l-ng-nb					
52	Basilanon	l-r-ng-nb	Iloilo	147	3	838.00	
53	Bas-og	r-ng-nb	Leyte				
54	Baticang	l-r-ng-b	Pangasinan	179	4	2,113.00	
55	Batlanganon	r-ng-nb					
56	Batuan	l-wh-ng-b	Pangasinan	186	4	1,920.00	
57	Batulinaw-lagkit	l-bl-ng-b	Tarlac	170	2	2,017.00	
58	Baybay	l-wh-ng-nb		194	3	2,575.00	
59	Baybayanon	wh-ng-nb	Capiz				
60	Bayon	l-r-ng-nb	Camarines	184	1	1,133.00	
1062	Bebe	u	Tarlac	132	4	2,290.00	
61	Bengala	l-wh-ng-nb	Ilocos Norte	144	6	2,198.00	
62	Bersabe	u-wh-ng-nb	Albay	132	2	2,845.00	
911	Bertone	l-wh-ng-b	France	137	2	421.00	
63	Biday	u-wh-ng-nb	Capiz	143	1	880.00	Same as Viday I
902	Biday I	u-wh-ng-nb	Iloilo	134	2	2,517.00	
903	Biday II	u-wh-ng-nb	Capiz	134	2	2,522.00	Same as Biday
64	Bilibid	u-wh-ng-nb	do	136	2	2,440.00	
65	Binabay	l-wh-ng-nb	Iloilo	140	2	1,390.00	
66	Binabaye I	u-wh-ng-nb	Batangas	129	1	1,550.00	
67	Binabaye II	u-wh-g-nb	Tayabas	135	2	2,728.00	Same as Inalang-ilang and Inilang-ilang
68	Binaboy	u-wh-ng-nb	Leyte	142	1	775.00	
69	Binakal I	l-wh-ng-b	Nueva Ecija	190	4	1,874.00	Same as Barog
1154	Binakal II		do	192	1	1,758.00	
70	Binacayao I	u-wh-ng-nb	Zambales	134	5	1,667.00	
71	Binacayao II	l-wh-ng-nb	do	137	6	1,892.00	
72	Binac-hao	l-r-ng-nb	Antique	179	2	2,111.11	
73	Binacloy	l-wh-ng-b	Pangasinan	187	3	1,629.00	
74	Binacroy I	l-wh-ng-b	do	166	13	2,800.40	Same as Cusimay-Buric, and Baliw

TABLE No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
1063	Binacroy II	l-wh-ng-b	do	------	------	----------	Same as Sinan-Fabian I, Dinaluson, Daluson á biit and Balolaqui
75	Binagacay I	l-wh-ng-b	Camarines	168	1	1,730.00	Same as Baranay
76	Binagacay II	l-wh-ng-b	Occidental Negros	188	5	2,321.00	Same as Cabang
77	Binaghay	u-wh-ng-nb	----------	151	1	1,200.00	
78	Binagontauo	u-wh-ng-nb	Camarines	137	8	1,668.00	
1201	Binalayang I	----------	Pangasinan	193	2	934.00	Same as Sampurado, Almisqui and Bacal
1064	Binalayang II	----------	do	------	------	----------	
79	Binalayong	u-wh-ng-nb	Antique	133	1	1,660.00	
80	Binalibod	l-wh-g-nb	Camarines	137	1	2,818.00	
81	Binalintin	----------	Laguna	------	------	----------	
1237	Binalintin Famy	----------	do	------	------	----------	
931	Binambang I	l-wh-ng-nb	do	194	6	2,881.33	
1155	Binambang II	l-wh-ng-nb	do	199	3	2,440.00	
82	Binangcal I	u-r-g-nb	----------	136	2	3,265.00	
1013	Binangcal II	wh-ng-nb	----------	152	1	2,056.00	
83	Binangquero	l-wh-ng-nb	Zambales	181	4	2,192.00	
1242	Biñang	l-wh-ng-nb	Cavite	195	2	2,914.00	
84	Binarire	u-wh-ng-nb	Occidental Negros	144	1	2,615.00	
85	Binarit I	u-r-ng-nb	Rizal	126	3	2,356.00	Same as Granada and Sinanglay-cabiitan
86	Binarit II	u-r-ng-nb	Capiz	141	1	1,464.00	
87	Binarit III	u-r-ng-nb	Zambales	150	1	2,506.00	Same as Balam, Bulagsac I and Luban I
88	Binatad	l-wh-ng-nb	Nueva Ecija	178	13	2,714.00	Same as Macantago I
89	Binatañgan	u-wh-g-nb	Bataan	143	1	1,260.00	
90	Binato I	l-wh-ng-nb	Tarlac	175	7	2,007.00	
1066	Binato II	l-wh-g-nb	do	174	4	2,135.75	Same as Bulastog (or Ortoc)
1156	Binato III	l-wh-g-nb	Nueva Ecija	177	1	2,403.00	
91	Binayabas	l-wh-g-b	La Union	169	3	2,088.00	
92	Binicol I	u-wh-ng-nb	Laguna	141	10	1,699.70	
937	Binicol II	l-wh-ng-nb	do	126	1	1,436.00	
93	Biningbing	u-wh-ng-nb	Bataan	135	1	835.00	
94	Binirajo	u-bl-ng-nb	Antique	143	1	1,510.00	Same as Capungot I
95	Binisaya	u-wh-ng-nb	Albay	140	2	2,283.00	
96	Binitoon	l-wh-ng-b	----------	164	1	1,703.00	
97	Binitoon-oldog	l-wh-ng-nb	Zambales	151	13	2,382.00	
98	Binmaley	l-wh-ng-b	Pangasinan	149	3	1,873.00	
99	Binogña I	u-r-ng-b	Albay	134	2	2,476.00	Same as Catorsa
100	Binolinao I	l-wh-ng-b	Zambales	163	1	1,663.00	
1203	Binolinao II	l-wh-ng-ng	do	149	2	1,904.00	
101	Binondoc I	u-wh-ng-nb	do	131	2	2,295.00	
967	Binondoc II	u-wh-ng-nb	Nueva Ecija	------	------	1,165.40	
102	Binugatan-Carcar	l-r-ng-nb	----------	186	3	2,852.00	
1243	Binuhañgin	l-wh-ng-nb	Bulacan	------	1	1,874.80	
103	Binuhañgin I	l-wh-ng-nb	Batangas	127	3	1,447.00	
104	Binuhañgin II	wh-ng-nb	Camarines	------	------	----------	
105	Binuhañgin III	l-wh-ng-nb	Cavite	18152	4	1,916.00	
106	Binuri	l-wh-ng-nb	Antique	188	5	2,371.00	
107	Bircacoc a bayag	l-wh-ng-nb	Tarlac	112	4	1,691.00	
108	Bircacoc a dalusong	l-wh-ng-nb	----------	169	7	2,670.00	
969	Binucawe	u-wh-ng-nb	Batangas	136	5	1,764.97	
977	Binulagsac I	wh-ng-nb	Bulacan	129	3	3,707.00	
1007	Binulagsac II	wh-ng-nb	Nueva Ecija	132	5	2,668.40	
1065	Binanata	l-wh-ng-b	Pangasinan	183	2	3,273.00	
1202	Bindigurin	----------	Lepanto	179	2	2,238.00	
1067	Binituin	l-wh-ng-b	Pangasinan	------	4	2,816.00	
109	Bisal	l-wh-g-b	Pangasinan	169	4	1,980.00	Same as Castañeda, Sambilac I, Sambilac III and Sinoyod
1290	Blue Rose I	----------	United States	------	------	----------	Same as Blue Rose II

TABLE No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
1291	Blue Rose II		do				Same as Blue Rose I
110	Boacnaga I	u-wh-ng-nb	Cebu	137	3	2,975.00	
1014	Boacnaga II	wh-ng-nb		151	1	1,266.00	
111	Bolinog	l-bl-ng-b	Zambales	164	4	1,958.00	
1253	Bong Dua						Same as Nang So
943	Bonguet	u-wh-ng-nb	Surigao	132	5	2,099.80	
112	Bonlay	l-wh-ng-nb	Camarines	140	8	2,487.00	
113	Borace	l-wh-ng-nb	Pangasinan	158	4	1,980.00	
114	Boracnaga	l-wh-ng-nb	Leyte	153	2	2,002.00	
115	Botanes	l-wh-ng-b	Pangasinan	161	7	1,946.00	
116	Bugatem I	l-wh-ng-nb	Cebu	138	6	2,212.00	
117	Bugatem II	l-wh-ng-nb		139	3	2,209.00	
118	Bulacnaga I	u-wh-ng-nb	Samar	139	1	890.00	Same as Bulagnaga, Caviteño and Fino
119	Bulacnaga II	u-wh-ng-nb	do	137	2	1,551.00	Same as Bulagnaga, Caviteño and Fino
120	Bulagsac I	u-r-ng-nb		129	2	3,731.00	Same as Balam Binarit and Lubang I
121	Bulagsac II	l-wh-ng-nb			1	3,097.00	Same as Sanglay puti
122	Bulagsac III	l-r-ng-nb		130	1	2,900.00	
123	Bulagsac-Blanco	u-wh-ng-nb	Zambales	132	2	2,930.00	
124	Bulagsac-Nagsalob	u-r-ng-nb	Bataan	129	1	2,550.00	
125	Bulagsac nà Inantipolo	u-wh-ng-nb	do	134	1	775.00	
126	Bulandi	u-wh-ng-nb	Occidental Negros	143	10	1,949.55	Same as Linion
127	Bulao I	u-wh-ng-nb	Albay	138	2	2,859.00	
128	Bulao II	l-wh-ng-nb	Sorsogon				
129	Bulao III	l-r-ng-nb	Albay	196	1	923.00	
1068	Bulao IV	u	Mindanao	118	5	2,829.20	
130	Bulaquique	l-wh-ng-nb	Occidental Negros	183	5	2,422.00	
1069	Bulastog or Ortoc	l-wh-g-nb	Pangasinan				Same as Binato II
131	Bulic I	l-wh-ng-nb	Zambales	168	3	2,164.00	
132	Bul-lilising I	l-wh-g-b	Ilocos Sur	187	3	1,652.00	
1070	Bul-lilising II	l-wh-g-nb	Pangasinan	180	4	1,483.50	
133	Bulineg	l-wh-ng-b	Zambales	172	3	2,117.00	
983	Buluhan	wh-ng-nb	Batanes	109	7	1,946.28	Same as Quinabebe II and Kiniristal
134	Buluhan dumali	l-wh-ng-nb		102	5	1,372.00	
135	Buluhan Silang	u-wh-ng-nb		124	2	2,105.00	
1157	Bulic II	l-ng-b	Nueva Ecija	168	4	1,849.00	
1071	Buncol	l-wh-ng-b	Pangasinan	187	4	1,764.00	
136	Bundoc	u-wh-ng-nb	Sorsogon				
974	Bungad	wh-ng-nb	Cotabato				
137	Burangcal	l-wh-ng-nb		157	2	1,900.00	
138	Burañgen	l-wh-ng-b	Tarlac	214	4	1,463.00	
139	Burata	l-wh-ng-nb	Iloilo	140	3	1,368.00	
140	Busisi I	u-wh-ng-nb		134	2	2,898.00	Same as Busise III and Malinanon
141	Busisi II	u-wh-ng-nb	Capiz	138	2	3,097.00	
142	Busisi III	u-wh-ng-nb		135	1	1,535.00	Same as Busise I and Malinanon
143	Butagan	u-wh-ng-nb	Misamis	144	6	1,534.00	
144	Caayad	u-r-ng-nb	Occidental Negros	140	1	1,685.00	
145	Cabadlong	l-wh-g-nb	do	157	2	1,600.00	
946	Cabagbag	u-wh-ng-nb	Iloilo	146	1		
146	Cabago I	l-wh-ng-nb	Iloilo	152	4	828.00	
949	Cabago II	u-wh-ng-nb	Occidental Negros	150	1	2,133.00	
147	Cabanay I	u-wh-ng-nb	Sorsogon	135	1	2,165.00	
1015	Cabanay II	wh-ng-nb		158	1	2,060.00	
148	Cabang	wh-ng-b		179	4	2,012.00	Same as Binagacay II
149	Cabañgin	u-wh-ng-nb		127	2	1,819.00	
150	Cabanglan	l-wh-ng-nb	Antique	152	5	1,796.00	
151	Cabangue	u-wh-ng-nb	do	143	1	780.00	

TABLE No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
152	Cabantong	l-wh-ng-nb	Bohol	137	11	2,368.60	
153	Caba-ong	u-wh-ng-nb					Same as Cabo-ong
154	Cabatiñgan	u-wh-g-nb	Capiz	135	2	2,436.00	
155	Cabayoran	l-wh-ng-b		188	4	1,905.00	
156	Cabellada	l-wh-ng-nb	Antique	131	5	1,728.00	
157	Cabiday	u-wh-ng-nb	Occidental Negros				
158	Cabilao	u-wh-ng-nb	do	135	2	2,057.00	Same as Quinao-ray
159	Cabita	r-ng-nb	Leyte				
160	Caboboy	r-ng-nb	do				
161	Cabogna	u	Occidental Negros				
162	Cabolan	l-wh-ng-nb	Bohol	143	3	1,856.00	
163	Cabonbon	u-wh-ng-nb	Occidental Negros	143	1	750.00	
164	Caboni	u-wh-ng-nb	Antique	144	1	1,490.00	Same as Porbida
165	Cabono	u-wh-ng-nb		139	1	2,125.00	
166	Cabonog	l-wh-ng-nb	Iloilo	143	3	819.00	
167	Caboong I	u-wh-ng-nb	Antique	141	1	980.00	Same as Caba-ong
168	Caboong II	u-r-g-nb	Bohol	141	1	2,850.00	
947	Caboong III	wh-ng-nb	Occidental Negros				
169	Caborgo	u-wh-ng-nb		138	2	1,491.00	
170	Caborong	l-wh-ng-nb	Antique	178	11	2,892.00	
171	Cabucay	u-wh-ng-nb	do	135	2	2,321.00	
172	Cabudbud	wh-ng-nb	Leyte				
173	Cabugnay	l-wh-ng-nb	Antique				
174	Cabulao	u-wh-ng-nb	Misamis				
175	Cabunlao	l-wh-ng-nb	Occidental Negros	146	2	1,215.00	Same as Calocot
995	Cabunlog-puti	l-wh-ng-nb	do	180	5	3,028.50	Same as Caputol
176	Cabuyo	l-wh-ng-nb	Samar	134	1	726.00	Same as Somarocsoc
177	Cabuyoc I	u-r-ng-nb	Misamis	141			Same as Calinquit
178	Cabuyoc II	l-wh-ng-nb	Samar	166	2	2,137.00	
179	Cadacag I	u-wh-ng-nb	Iloilo	141	1	2,500.00	Same as Cadocag II
180	Cadacag II	u-wh-ng-nb	Iloilo	141	4	1,238.00	Same as Cadocag I
181	Cadaguit I	u-r-ng-nb	Antique	139	1	1,800.00	
182	Cadaguit II	l-bl-ng-nb	do	207	1	346.00	Same as Casaquit
183	Cadimaya	u-wh-ng-nb	Capiz	137	2	1,997.00	
184	Cadocag	l-wh-ng-nb	Occidental Negros	159	1	567.00	
185	Cagaid	u-wh-ng-nb	Antique	138	1	2,640.00	
984	Cagatusan	l-wh-ng-nb	Cotabato	165	5	2,996.00	
186	Cainti I	u-wh-ng-nb	Bohol	128	1	2,965.00	
187	Cainti II	l-wh-ng-nb	do	138	3	2,068.00	
1244	Cainti III	l-wh-ng-nb	Bohol		1	2,594.20	
188	Cairog	u-wh-ng-nb	Batangas	137	2	2,995.00	
189	Calaguio	u-wh-ng-nb	Capiz	139	1	1,565.00	Same as Ulian
190	Calahoy I	l-wh-ng-nb	do	135	3	2,040.00	
1016	Calahoy II	wh-ng-nb	Capiz	146	1	321.00	
191	Calampoñgan	l-wh-ng-nb	Occidental Negros	141	2	1,274.00	Same as Calonod and Capantao
192	Calamyan	l-wh-ng-nb	Bohol	120	2	823.00	
193	Calanay I	u-wh-ng-nb	Antique	136	2	2,191.00	Same as Capino II
194	Calanay II		Capiz				
195	Calanay III	u-wh-g-nb	Romblon	140	1	264.00	
196	Calanay IV	u-wh-g-nb	Occidental Negros	142	1	1,065.00	Same as Gumalit
197	Calanay V	u-wh-g-nb	Antique	142	1	228.00	
1204	Calanlanyan		Nueva Ecija	196	2	1,081.00	
198	Calangay	l-wh-ng-b	Tarlac	202	4	1,256.00	
199	Calangcang	u-r-ng-nb	Antique	142	1	2,250.00	
200	Calangyo I	u-wh-ng-nb	Capiz	136	2	2,567.00	Same as Calangyo II
201	Calangyo II	u-wh-ng-nb		135	2	2,536.00	Same as Calangyo I

TABLE NO. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
202	Calanoche	l-wh-g-b	Ilocos Norte	162	3	2,195.00	
203	Calañag	u-wh-ng-nb	Oriental Negros	140	1	2,040.00	**Same as Calañang**
204	Calañang	u-wh-ng-nb	Occidental Negros	140	1	1,985.00	**Same as Calañag**
205	Calapdos	u-wh-ng-nb	Oriental Negros	143	2	944.00	
206	Calaquinggay	u-wh-g-nb	Antique	141	1	1,470.00	
207	Calasanon	l-wh-ng-nb	Bukidnon	145	5	926.00	**Same as Hindaganon**
208	Calaua	l-wh-ng-nb	----------	184	6	2,212.00	
209	Calaya	u-bl-g-nb	Capiz	134	2	1,753.00	
210	Calibo I	u-wh-ng-nb	Bulacan	134	2	3,598.00	
211	Calibo II	u-wh-ng-nb	Laguna	136	------	----------	
1072	Calibo III	l-wh-ng-nb	Nueva Ecija	164	4	3,040.00	
1073	Calibug	u	Occidental Negros	130	5	1,147.80	
212	Caligaya I	u-r-ng-nb	Bulacan	124	2	2,289.00	
213	Caligaya II	----------	Laguna	------	------	----------	
214	Caligaya III	u-r-ng-nb	Rizal	135	1	2,475.00	
215	Caligaya IV	l-wh-ng-nb	Laguna	148	1	614.00	
216	Calinao I	u-wh-ng-nb	Antique	143	1	1,560.00	
217	Calinao II	l-r-ng-nb	do	155	2	1,493.00	
218	Calinguit	u-r-ng-nb	Misamis	140	1	725.00	**Same as Caluyoc I**
219	Calipay I	l-wh-ng-nb	Antique	173	1	3,400.00	
944	Calipay II	u-wh-ng-nb	Surigao	110	1	2,780.00	
220	Calirit	l-wh-ng-nb	----------	136	2	1,650.00	
221	Caliso	l-wh-ng-nb	Occidental Negros	149	1	1,858.00	
222	Calivo I	u-wh-ng-nb	Cavite	136	2	2,584.00	**Same as Talankao**
223	Calivo II	u-wh-ng-nb	Zambales	138	2	2,581.00	
226	Calocot	l-wh-ng-nb	Occidental Negros	146	2	1,422.00	**Same as Cabunlao**
227	Calodo	l-wh-g-nb	----------	185	5	2,041.00	**Same as Manabaco**
228	Calong	u-wh-ng-nb	Misamis	130	1	1,485.00	
229	Calonod	l-wh-ng-nb	Oriental Negros	143	3	988.00	**Same as Calampongan and Capantao**
230	Calotoc	l-wh-ng-nb	Occidental Negros	143	2	869.00	
231	Calubad I	l-bl-g-nb	do	144	2	685.00	
232	Calubad II	l-r-ng-nb	Antique	162	1	715.00	
224	Calubad III	l-r-ng-nb	do	151	4	2,339.00	
225	Calobang I	l-wh-ng-nb	Iloilo	187		2,514.00	**Same as Calobang II**
479	Calobang II	wh-ng-nb	----------	------	------	----------	**Same as Calobang I**
233	Calumpit	l-wh-ng-nb	do	157	2	2,223.00	**Same as Diamante IV and Saigon IV**
234	Caluñgi	l-wh-ng-b	Misamis	137	2	1,351.00	
235	Calu-os	l-wh-ng-nb	Antique	145	1	1,450.00	
236	Caluros	u-wh-ng-nb	Oriental Negros	140	1	1,375.00	
237	Calutac	u-wh-ng-nb	Misamis	127	1	1,890.00	
238	Camarines	u-wh-ng-nb	Occidental Negros	------	------	----------	
239	Camiling I	l-wh-ng-b	Zambales	193	3	2,063.00	
1017	Camiling II	l-wh-g-b	Pangasinan	184	------	----------	**Same as Hermosa, Salasa, Inalasan, Pololante and Diquet a Olandez**
1158	Cammang	l-ng-b	Nueva Ecija	132	3	2,292.00	
240	Camunay	----------	Albay	------	------	----------	
241	Canato	u-wh-ng-nb	Antique	141	1	2,900.00	
242	Cancang	l-wh-ng-nb	Bohol	133	2	1,066.00	
243	Candelaria I	l-wh-ng-b	Pangasinan	220	4	1,299.00	
1074	Candelaria II	l-wh-ng-b	do	201	4	2,837.00	
1205	Candinaria	----------	Tarlac	213	2	391.00	
244	Cañgolia	l-wh-ng-nb	----------	153	1	293.00	
245	Cañgon	l-wh-ng-nb	Misamis	122	2	1,025.00	
246	Caoñgedy	l-wh-ng-nb	Cebu	129	5	2,664.00	
247	Capache	u-bl-g-nb	Capiz	141	2	2,340.00	

TABLE NO. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
252	Capao-pula	l-r-ng-nb	Antique	154	2	1,908.00	Same as Tuhao I
248	Capagsic	l-wh-ng-nb	Oriental Negros	142	2	938.00	
249	Capanod	u-bl-g-nb	Capiz	130	1	1,975.00	Same as Capaod
250	Capantao	u-wh-ng-nb	Antique	143	1	1,535.00	Same as Calampongan and Calonod
251	Capaod	u-bl-g-nb	Capiz	131	2	1,989.00	Same as Capanod
253	Capaque	l-bl-ng-nb	----------	144	3	1,364.00	
254	Capichola	u	Oriental Negros	142	1	1,500.00	
948	Capigsic	u-wh-ng-nb	Occidental Negros	145	1	3,120.00	
255	Capigued I	l-wh-ng-b	Zambales	189	6	2,153.00	
1075	Capigued II	l-wh-ng-b	Pangasinan	206	13	1,514.00	
256	Capingcao	l-wh-ng-nb	Antique	143	4	1,436.00	
257	Capino I	u-wh-ng-nb	----------	138	3	1,945.00	Same as Inocot
258	Capino II	u-wh-ng-nb	Capiz	138	2	2,627.00	Same as Calanay I
259	Capiznon	wh-ng-nb	Leyte	------	------	----------	
1005	Caporcas	wh-ng-nb	Iloilo	------	------	----------	
260	Caporcas I	u-wh-ng-nb	Capiz	127	2	2,369.00	Same as Julilan
261	Caporcas II	u-wh-ng-nb	----------	134	2	1,716.00	
262	Capotol	l-wh-ng-nb	Bohol	138	5	2,574.00	Same as Barangcal
263	Capucao I	u-r-ng-nb	Occidental Negros	136	2	2,510.00	
264	Capucao II	u-wh-ng-nb	Capiz	133	2	2,598.00	
265	Capuñgot I (short)	l-bl-ng-nb	Antique	142	2	781.00	Same as Binirajo
266	Capuñgot II (long)	u-bl-ng-nb	do	143	1	1,185.00	
267	Capuñgot III	u-wh-ng-nb	Capiz	141	1	1,282.00	
268	Caputol I	u-wh-ng-nb	Albay	145	7	1,907.00	Same as Cabunlog-puti
269	Caputol II	u-wh-ng-nb	Oriental Negros	143	6	2,062.00	
270	Caputol III	l-wh-g-nb	Sorsogon	161	2	1,242.00	
271	Caputol IV	l-bl-ng-nb	do	161	1	2,082.00	
272	Caputol V	l-wh-ng-nb	Albay	145	1	2,078.00	
940	Caputol VI	l-wh-ng-nb	Occidental Negros	197	4	3,308.00	
273	Carangcang	u-wh-ng-nb	Samar	145	1	425.00	
274	Carangcang ñga itom	u-wh-ng-nb	Antique	141	1	2,470.00	
275	Caraui I	l-wh-ng-nb	Occidental Negros	140	3	1,200.00	
276	Caraui II	u-wh-ng-nb	Misamis	138	1	1,660.00	
277	Carauis	u-wh-ng-nb	Leyte	134	3	2,322.00	
278	Caraya I	u-wh-ng-nb	Antique	134	2	2,648.00	
279	Caraya II	u-r-ng-nb	do	139	1	1,475.00	
280	Caricot	u-wh-ng-nb	Oriental Negros	------	------	----------	
281	Carinay	u-r-ng-nb	----------	133	2	2,269.00	
1076	Cariñosa	l-wh-ng-nb	Pangasinan	204	2	2,191.00	
282	Caririt	----------	----------	------	------	----------	
283	Carnate	u-r-g-nb	Antique	141	1	4,259.00	
284	Carolina	u-wh-ng-nb	Occidental Negros	124	1	950.00	
285	Carolina Golden I	l-wh-ng-nb	----------	130	4	1,493.00	Same as Tabao
1267	Carolina Golden II	----------	----------	------	------	----------	
286	Caromayan	l-wh-ng-nb	Occidental Negros	121	2	965.00	
287	Caroray	l-wh-ng-nb	Iloilo	139	2	595.00	
288	Caruña	u-wh-ng-nb	Bukidnon	124	2	2,278.00	
289	Casacao I	u-wh-ng-nb	Iloilo	140	1	1,620.00	
290	Casacao II	l-wh-ng-nb	Capiz	147	2	401.00	
291	Casaquit	l-bl-ng-nb	Antique	175	2	1,444.00	Same as Cadaquit II
293	Cosibong	l-wh-g-nb	Pangasinan	155	4	1,613.00	Same as Inorani
976	Cosicad	l-wh-ng-nb	Capiz	136	5	2,312.40	
294	Caso-ay	l-r-ng-nb	Occidental Negros	140	2	1,464.00	
295	Casobong	l-wh-ng-nb	Bulacan	191	12	2,584.90	Same as Casugon
296	Castañeda	l-wh-g-b	Pangasinan	173	------	----------	Same as Bisal, Sambilak III, and Sinoyod

TABLE No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
930	Casthuri Champa	l-ng-nb	Indo-China	141	1	1,238.00	
297	Casugon	l-wh-ng-nb	Zambales	191	4	1,639.00	Same as Casobong
1146	Casulig	u	Occidental Negros	141	4	1,670.50	
945	Catalong	u-wh-ng-nb	Oriental Negros	143	5	2,431.20	
298	Catamlagnan	u-r-ng-nb	Albay	141	1	2,925.00	
299	Catan-ag	l-wh-ng-nb		122	6	1,336.00	
1018	Catanod	wh-ng-nb			1	547.00	
300	Catibos	l-wh-ng-nb	Iloilo	126	2	619.00	
301	Catinao	l-wh-ng-nb	Antique	172	1	2,300.00	
302	Catlon-bulan	l-wh-ng-nb	Ilocos Norte	137	5	1,757.00	
303	Caton-og I	u-wh-ng-nb	Occidental Negros	140	2	1,595.00	Same as Culaui and Tigbauanon
304	Caton-og II	l-wh-ng-nb	Capiz	151	2	1,147.00	
305	Catorce	u-wh-ng-nb	Antique	141	1	2,665.00	Same as Guiron
306	Catorsa	u-r-ng-nb	Bohol	133	2	3,165.00	Same as Binogña
307	Catsori	l-wh-ng-nb	Occidental Negros	134	2	1,409.00	
308	Catunda	l-wh-ng-nb	Iloilo	141	3	520.00	
309	Catutoc	u-wh-ng-nb	do	143	2	2,950.00	
310	Cauaas	u-wh-ng-nb	Samar	118	2	2,502.00	
311	Cauili	u-wh-ng-nb	Antique	136	1	1,010.00	
1159	Caviteña	l-wh-g-nb	Ilocos Norte	154	3	2,014.00	
315	Caviteño	u-wh-ng-nb	Bulacan	136	2	1,712.00	Same as Bulacnaga I, Bulacnaga II, and Fino
1206	Caviteña-Ablong		Tarlac	175	2	1,050.00	
312	Caviteña-Iloco	l-wh-ng-b	do	158	4	2,036.00	
313	Caviteñang nagmaliw	l-wh-ng-nb	Nueva Ecija	173	7	2.183.00	
314	Caviteña-Tagalog	l-r-ng-nb	do	163	4	2,207.00	
1078	Caviteña I	l-wh-ng-b	Pangasinan	155	3	2,277.00	
1079	Caviteña II	l-wh-ng-b	do	130	2	1,327.75	
316	Cayading I	l-r-ng-b	do	211	3	1,495.00	
1081	Cayading II	l-wh-ng-b	do	185	4	2,485.00	
1082	Cayading a nalabaga	l-wh-ng-b	do	187	4	2,502.00	
970	Cayangkang		Occidental Negros	141	4	1,561.00	
1080	Cayabeng I	l-wh-ng-b	Pangasinan	171	4	2,885.00	
1207	Cayabeng II		do	172	2	1,800.00	
317	Cayahan	u-wh-ng-nb		146	1	1,705.00	Same as Palaynon
1208	Cayapa		Nueva Ecija	211	2	1,009.00	
318	Cayaya	u-wh-ng-nb		139	1	2,040.00	Same as Saca
319	Caledoña I	u-wh-ng-nb	Antique	134	2	1,567.00	
320	Caledoña II	u-wh-ng-nb	Capiz	140	2	2,510.00	
321	Clarito	u-wh-ng-nb	Indo-China	133	2	2,463.00	
928	Cocong	l-wh-ng-nb	do	203	1	1,763.00	
322	Kucong uwak I	l-r-g-nb	Camarines	144	2	1,504.00	Same as Kucong uwak II and Polotan sa Mayobo
323	Kucong uwak II	l-r-g-nb		148	3	1,709.00	Same as Kucong uwak I and Polotan sa Mayobo
324	Coliit	u-wh-ng-nb	Tayabas	136	2	2,708.00	
325	Compas	u-wh-ng-nb		144	1	1,785.00	
1002	Conner	l-wh-ng-nb	Bureau of Agriculture				
1083	Contenido I	l-wh-ng-b	Pangasinan	210	3	2,171.00	
1084	Contenido II	l-wh-ng-b	do	207	2	2,678.00	
1085	Contenido III	l-wh-ng-b	do	205	3	1,957.00	
326	Corales	u-r-g-nb	Cagayan	126	2	2,603.00	
327	Coran	u-wh-ng-nb	Occidental Negros				
328	Coratsay	l-r-ng-nb	Antique	156	2	1,694.00	
329	Cordellero	l-wh-ng-b		189	1	862.00	
330	Coricol		Capiz				
292	Casibe	l-wh-ng-b	Nueva Ecija	208	4	1,301.00	
1019	Cotiong	l-g-nb			1	1,747.00	

TABLE NO. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
331	Cutsiam I	u-r-ng-nb	Bohol	136	2	2,038.00	Same as Mañgilala
1147	Cutsiam II	u	Occidental Negros	125	5	1,921.00	
332	Cutsiam III	u-r-ng-nb	Antique	129	1	1,525.00	Same as Quinupang
1003	Cruz	l-wh-ng-nb	Bureau of Agriculture	------	------	----------	
1160	Cucuam	u	Nueva Ecija	134	3	1,256.66	
333	Culaui	l-wh-ng-nb	----------------	144	2	996.00	Same as Catonog and Tigbauanon
334	Cusimay-buric	l-wh-ng-b	Pangasinan	166	4	2,552.00	Same as Binacroy and Baliw
335	Casimay-nalabaga	l-wh-ng-b	do	179	4	1,590.00	
336	Dalaog	l-wh-ng-nb	Misamis	161	3	1,567.00	
337	Daldal	l-r-ng-b	----------------	181	3	2,143.00	
1086	Daldal-lot	wh-g-nb	Pangasinan	------	------	----------	
338	Dali	l-wh-ng-nb	Albay	166	3	889.00	
339	Dal-legan	r-ng-b	Nueva Vizcaya	------	------	----------	
340	Dal-lidal-lot	l-wh-g-b	Pangasinan	187	4	1,418.00	
341	Daliket	u-wh-ng-nb	Camarines	101	5	1,562.00	
966	Daliket or Sanglay	wh-ng-nb	Cavite	121	3	2,652.00	
342	Dalua	l-wh-ng-nb	Misamis	160	1	1,453.00	Same as Tarbayanon I and Tarbayanon II
343	Dalusan	l-wh-ng-b	Antique	190	2	1,690.00	
344	Dalusong	l-wh-ng-b	Zambales	164	7	2,302.00	Same as Mañgaldan
1087	Dalusong a biit	wh-ng-b	Pangasinan	------	------	----------	Same as Balolaqui, Dinaluson, Sinan-Fabian II, and Binacroy II
345	Dame	u-wh-ng-nb	----------------	143	1	1,440.00	
346	Dachog	l-wh-ng-nb	Antique	148	4	1,944.00	
347	Dapog	u-wh-ng-nb	Bukidnon	143	2	3,159.00	
348	Dasol	l-wh-ng-nb	Zambales	154	13	2,551.11	
349	Dauling	l-r-ng-nb	----------------	143	3	1,795.00	
350	Dayami	u-wh-ng-nb	Occidental Negros	134	2	1,670.00	
351	Daya-ot uban	bl-g-b	Nueva Vizcaya	------	------	----------	
352	Dayhaganon	u-wh-ng-nb	Bukidnon	139	2	2,219.00	
353	Dayami tapol	u-bl-ng-nb	Oriental Negros	141	1	750.00	
354	Dayoyo I	u-wh-g-nb	Occidental Negros	135	2	1,840.00	Same as Dayo II
355	Dayoyo II	u-wh-g-nb	Capiz	135	2	2,463.00	Same as Dayoyo I
356	Dayoyo III	u-wh-g-nb	----------------	135	2	2,185.00	
357	Diamante I	u-wh-ng-nb	Occidental Negros	134	2	1,560.00	Same as Puerto
358	Diamante II	u-wh-ng-nb	Antique	143	1	1,400.00	
359	Diamante III	u-wh-ng-nb	do	143	1	1,735.00	
360	Diamante IV	l-wh-ng-nb	do	161	------	----------	Same as Calumpit and Saigon IV
361	Diamante V	l-wh-ng-nb	Cebu	150	1	2,500.00	
362	Dinagat I	u-wh-ng-nb	Batangas	123	5	1,904.00	
363	Dinagat II	u-wh-ng-nb	Laguna	129	8	1,845.00	
965	Dinagat III	wh-ng-nb	Laguna	------	------	----------	
364	Dinalaga I	l-wh-g-nb	Tayabas	130	3	2,670.00	
365	Dinalaga II	l-wh-ng-b	Tarlac	168	7	1,826.00	Same as Inomalit
366	Dinalaga III	u-r-ng-nb	Zambales	128	5	2,165.00	Same as Macatlo
953	Dinalaga IV	u-wh-ng-nb	Rizal	143	1	3,640.00	
1161	Dinalaga V	ng-nb	do	130	3	1,832.66	
1162	Dinalaga VI	l-wh-ng-nb	do	166	3	2,825.00	
1411	Dinalagang Muñoz	--------------	Nueva Ecija	------	------	----------	
367	Dinamiana	u-wh-ng-nb	Batangas	131	2	2,528.00	
1088	Dinaluson	wh-ng-b	Pangasinan	171	1	3,645.00	Same as Sinan-Fabian III, Binacroy II, Dalusong a biit, and Balolaki I

TABLE NO. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
368	Dinicola	l-wh-ng-b	Zambales	183	3	1,623.00	
369	Dinominga I	l-wh-ng-nb	do	175	3	1,946.00	
370	Dinominga II	l-wh-ng-b	Nueva Ecija	153	7	1,818.00	
371	Dinorado	l-wh-ng-nb	Zambales	130	5	1,536.00	
1020	Diquet a Olandez	l-wh-g-b	------	181	------	------	**Same as Hermosa, Salasa, Polalante, Inalasan and Camiling**
1089	Diquet a Pinasgad	u	Pangasinan	143	4	1,337.50	
1210	Diquet Saba	l-wh-ng-nb	Ilocos Norte	177	2	1,325.00	
372	Dollar	l-wh-ng-b	Pangasinan	202	4	1,759.00	
918	Dry Mountain	wh-ng-nb	France	------	------	------	
373	Dumaling-kaawa	l-wh-ng-nb	Batangas	162	3	1,316.00	Same as Magasawang-palay
374	Dumpas	u-wh-ng-nb	------	141	2	2,020.00	Same as Lanconon
375	Dumudao	u-wh-ng-nb	Misamis	144	1	610.00	
376	Eaca	l-wh-ng-nb	Capiz	135	3	1,243.00	
377	Eacapino	l-r-ng-b	------	143	3	1,828.00	
1266	Early Prolific	------	------	------	------	------	
912	Egyptian Fine	l-wh-ng-b	France	------	------	------	
913	Egyptian Yamani	wh-ng-nb	do	------	------	------	
920	Egyptian Sultanic	l-wh-ng-b	do	151	2	442.00	
378	Eninian	l-wh-ng-nb	Occidental Negros	143	4	1,330.00	
379	Eput-ebon I	l-wh-ng-nb	Tarlac	166	13	2,161.12	
462	Eput-ebon II	l-r-ng-nb	Pampanga	159	3	2,049.00	
1163	Español	l	Ilocos Norte	207	2	1,777.50	
380	Espiritu	l-wh-ng-b	Pangasinan	187	4	2,031.00	
381	Fino I	u-wh-ng-nb	Albay	138	2	1,931.00	Same as Bulacnaga I, Bulacnaga II, Caviteño
1021	Fino II	wh-ng-nb	Albay	------	------	753.00	
1280	First Crop Glutinous Rice	------	China	95	1	562.00	
382	Fiscal	l-wh-ng-b	Nueva Ecija	192	3	1,563.00	
1263	For Dung Bap	------	China	------	------	------	
914	Francone	wh-ng-nb	France	------	------	------	
383	Gamay	u-wh-ng-nb	Antique	144	1	1,925.00	
1209	Ganado	------	Nueva Ecija	182	2	1,991.00	
1090	Ganado a bayag	l-wh-ng-b	Pangasinan	203	4	2,105.00	
1091	Ganado a biit	l-wh-ng-b	do	199	4	1,497.00	
384	Ganado a lacay	l-wh-ng-b	Tarlac	186	4	1,814.00	
1092	Ganado a nalabaga	l-wh-ng-b	Pangasinan	176	4	2,059.66	
385	Garaygay	l-wh-ng-b	do	170	6	2,148.00	
386	Gayang	l-wh-g-b	Nueva Vizcaya	182	1	1,383.00	
387	Gayangang-blanco	u-r-ng-nb	Albay	133	2	3,194.00	
388	Gayangang negro	u-bl-ng-nb	do	140	2	1,484.00	
389	Ginaloan	u-wh-g-nb	------	135	2	1,803.00	Same as Hinlu-ay pilit
390	Gono	u-wh-ng-nb	Capiz	136	2	2,279.00	
391	Goyod I	l-wh-ng-nb	Nueva Ecija	142	2	1,394.00	
392	Goyod II	l-wh-ng-b	Pangasinan	165	2	1,933.00	
1211	Goyod III	------	Tarlac	213	2	788.00	
393	Goyodan	l-wh-ng-b	Pangasinan	159	4	1,860.00	Same as Iray, Manteca a Nalabaga and Grana II
394	Gracia	l-wh-ng-b	Tarlac	183	4	1,531.00	
395	Grana I	l-r-ng-nb	Zambales	165	4	2,158.00	
396	Grana II	l-wh-ng-b	Pangasinan	177	9	2,688.00	Same as Iray, Goyodan, and Manteca a Nalabaga
397	Grana a Purao	l-wh-ng-nb	do	175	7	2,020.00	
398	Grana-sabutan	l-wh-ng-b	Zambales	179	4	2,062.00	Same as Bacnotan
399	Granada	u-r-ng-nb	do	125	2	3,350.00	Same as Binarit I and Sinanglay cabiitan
400	Granate	u-wh-g-nb	Occidental Negros	144	1	735.00	
401	Granatis	l-wh-ng-nb	Ilocos Sur	164	2	2,290.00	
402	Guinanado	l-wh-ng-b	Pangasinan	173	3	2,238.00	
403	Guinanahan	u-wh-ng-nb	------	146	------	------	

TABLE NO. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
404	Guinarab	l-wh-ng-nb	Antique	140	2	1, 273. 00	
405	Guinaroan	l-r-g-nb	Iloilo	189	3	1, 799. 00	
406	Guinulong I	l-wh-ng-nb	Antique	140	12	2, 314. 50	Same as Gumaid II
408	Guinulong II	u-wh-ng-nb	Bataan	141	1	1, 900. 00	Same as Pregonse
407	Guinoyoran	l-wh-g-b	Zambales	167	4	2, 037. 00	
409	Gui-os I	u-wh-ng-nb	Antique	133	1	2, 210. 00	
410	Gui-os II	l-wh-ng-nb	do	135	2	1, 456. 00	
411	Guiron	u-wh-ng-nb	do	140	1	1, 585. 00	Same as Catorce
955	Guinatus	u-wh-ng-nb	Iloilo	147	1	3, 467. 00	
1093	Guinandolan biit	l-wh-ng-b	Pangasinan	188	4	1, 952. 00	
968	Guinangang	l-wh-ng-nb	Laguna	136	6	3, 666. 00	
1094	Guinaracia	wh-ng-b	Pangasinan	185	4	2, 688. 66	
1095	Guinarana	l-wh-ng-nb	do	155	4	2, 357. 00	
954	Guluya	u-wh-ng-nb	Laguna	139	1	2, 927. 00	
412	Gumaid I	u-wh-g-nb	Capiz	137	3	3, 675. 00	
413	Gumaid II	wh-ng-nb	Occidental Negros	143	6	2, 135. 00	Same as Guinolong
414	Gumalit	u-wh-g-nb	------	140	1	2, 580. 00	Same as Calanay IV
415	Guyod I	u-wh-ng-nb	Iloilo	139	2	1, 920. 00	
416	Guyod II	u-wh-ng-nb	Occidental Negros	143	1	2, 115. 00	Same as Agabon
417	Halbayanon	l-wh-ng-nb	do	150	6	2, 110. 00	
1022	Hermosa	l-wh-g-b	------	182	------	------	Same as Salasa, Inalasan, Polalante, Diquet a Olandez; and Camiling
418	Hindagonan	u-wh-ng-nb	------	146	1	685. 00	Same as Calasonon
419	Hinlu-ay pilit	u-wh-g-nb	------	140	1	2, 240. 00	Same as Guinaloan
999	Hinirang	l-wh-ng-nb	Zambales	136	8	2, 293. 00	
420	Hispoc	l-wh-g-nb	------	155	3	1, 598. 00	
1264	Honduras	------	------	------	------	------	
1262	Hue Ky	------	------	------	------	------	
421	Ignacio	u-wh-g-nb	Cebu	123	2	2, 619. 00	
422	Igorot I	l-wh-ng-b	Zambales	135	3	1, 539. 00	
423	Igorot II	l-wh-ng-b	Tarlac	215	4	1, 314. 00	
424	Ilajas	l-wh-ng-nb	Iloilo	139	2	1, 052. 00	
425	Ilañgitnon	l-r-ng-nb	------	185	3	2, 324. 00	
426	Ilog	l-wh-ng-nb	Occidental Negros	192	5	2, 269. 00	
428	Imos	l-r-ng-nb	Zambales	165	4	1, 743. 00	
427	Imung daya-ot	l-wh-g-b	Nueva Vizcaya	184	1	1, 591. 00	
429	Inachupal I	l-wh-ng-nb	Tarlac	169	18	2, 624. 80	
1164	Inachupal II	l-ng-nb	Pampanga	181	3	2, 933. 66	
430	Inacloy	l-wh-ng-b	------	173	3	2, 104. 00	
431	Inaculao	l-wh-ng-b	Pangasinan	189	4	1, 811. 00	
1212	Inadhica	l-wh-ng-nb	Cavite	194	2	2, 590. 50	
939	Inagamang	wh-ng-b	La Union	130	------	------	
432	Inagoyan	u-wh-ng-nb	------	148	1	680. 00	
1023	Inaguew I	wh-ng-nb	Capiz	183	1	1, 586. 00	
435	Inaguew II	l-wh-ng-nb	Antique	154	5	2, 395. 00	
1213	Inagsaya	------	Batangas	131	2	1, 721. 00	
433	Inaguas grandes	l-wh-ng-nb	Camarines	149	2	2, 069. 00	Same as Inaguas pequeñas
434	Inaguas pequeñas	l-wh-ng-nb	do	149	2	1, 990. 00	Same as Inaguas grandes
436	Inagul	u-wh-ng-nb	Capiz	132	2	2, 119. 00	
437	Inalanao	u-wh-ng-nb	Albay	136	2	1, 530. 00	
438	Inalangilang	u-wh-g-nb	Tayabas	136	2	2, 819. 00	Same as Binabaye II and Inilangilang
439	Inalsa	l-r-ng-nb	Tarlac	165	4	1, 905. 00	
1024	Inalasan	l-wh-g-b	------	153	------	------	Same as Hermosa, Salasa, Polalante, Diquet a Olandez, and Camiling
440	Inanadios	l-wh-ng-nb	------	137	3	2, 151. 00	
1025	Inandoran	wh-ng	------	197	1	2, 360. 00	
441	Inangel	u-bl-g-ng	Bataan	139	1	2, 665. 00	
442	Inangue	u-wh-ng-nb	do	147	1	1, 255. 00	
443	Inanis	u-wh-ng-nb	Bulacan	138	2	2, 239. 00	
936	Inanod I	u-wh-ng-nb	Cavite	143	5	1, 959. 80	

TABLE No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
1026	Inanod II	wh-ng-nb		144	1	796.00	
444	Inantipolo I	u-wh-ng-nb	Batangas	136	1	1,840.00	**Same as Pilengbaybay**
956	Inantipolo II	u-wh-ng-nb	Cavite	138	5	2,378.60	
445	Inaransing	u-r-g-nb	Albay	138	2	2,181.00	Same as Marigaya
446	Inaropel I	l-wh-ng-b	Pangasinan	199	4	1,748.00	
456	Inaropel II	u-r-g-nb	Zambales	134	2	2,223.00	**Same as Milagrosa and Sinibuyas I**
447	Inasimang	l-wh-ng-nb	Tarlac	170	12	2,854.00	
448	Inaslon	u-wh-ng-nb	Antique	143	2	1,293.00	
449	Inespaña	u-r-g-nb	Tarlac	136	2	1.955.00	
450	Inilang-ilang	u-wh-g-nb	Laguna	142	1	1,600.00	Same as Binabaye II and Inilang-ilang
451	Inipon I	l-wh-ng-b	Nueva Ecija	182	7	1,865.00	
1009	Inipon II	wh-ng-nb	Pangasinan				
1096	Inipon III	l-wh-ng-b	do	159	4	2,661.00	
1048	Inintiw	u	Laguna	123	1	1,975.75	
989	Itani	wh-ng-nb	Tarlac	126	5	2,300.00	
1932	Initiwtiw	l-wh-ng-nb	Laguna	118			
1097	Initlogdalag	u	Cavite	131	4	2,197.00	
452	Inocot	l-wh-ng-nb	Oriental Negros	139	2	966.00	Same as Capino I
453	Inolayan	u-wh-ng-nb	do	141	1	900.00	
454	Inomalit		Pangasinan				Same as Dinalaga II
455	Inorani		Zambales				Same as Casibong
1098	Inosema	l-wh-ng-b	Mindanao	182	3	2,091.00	
457	Inuay I	u-wh-ng-nb	Batangas	137	2	2,325.00	Same as Pilapil II and Taho-dilahas
458	Inuay II		Tayabas				Same as Pinamungang tunay
1214	Interprete		Ilocos Norte	213	2	772.00	
459	Inudiong I	l-wh-ng-nb	Zambales	149	2	2,107.00	Same as Pinascuala I
460	Inudiong II						
461	Inuwak	l-wh-g-b	Zambales	173	4	1,472.00	
463	Iray	l-wh-ng-b	Pangasinan	160	13	2,438.00	Same as Goyodan, Manteca a Nalabaga, Grana II and Minantica II
464	Ituin oldog	l-wh-ng-nb	Zambales	136	4	2,015.00	
465	Itui-uroc	l-r-ng-nb		143	3	2.394.00	
1215	Japanese rice		Japan	122	2	369.00	
468	Jasmin	l-wh-ng-b	Zambales	163	3	2,124.00	
466	Jayisian I	r-g-b	Nueva Vizcaya				
467	Jayisian II	bl-ng-nb	do				
469	Jinaloan	l-wh-g-nb	Occidental Negros	183	4	2,259.00	
470	Jinipon	l-wh-ng-nb	Capiz	170	6	2,521.00	
471	Jinos	l-wh-ng-nb	Oriental Negros	145	4	1,561.00	
472	Joani	l-wh-ng-nb	Zambales	156	7	1,895.00	Same as Postoguer
473	Joquianan	l-wh-ng-nb	Iloilo	190	12	2,364.38	Same as Tuguianan
474	Judgan	r-ng-nb	Nueva Vizcaya				
475	Judlot	l-wh-ng-nb	Antique	143	5	2,014.00	
476	Julilan	l-wh-ng-nb		129	5	1,195.00	Same as Caporcas I
477	Jungusnge	r-ng-nb	Nueva Vizcaya				
990	Kaawa	wh-ng-nb	Rizal	125	5	2,306.20	
1077	Kastila I	l-wh-ng-b	Pangasinan	210	3	1,889.00	
1195	Kastila II		do	212	2	1,578.50	
951	Kalibod	u-wh-ng-nb	Capiz	133	6	2,260.50	
478	Kalo	u-wh-ng-nb		141	1	2,175.00	

TABLE No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
480	Kalutac	l-wh-ng-nb	Misamis	148	1	505.00	
1248	Kathisod	l-wh-g-nb	Siam	159	1	3,481.00	
1247	Khao Bai Sri	l-wh-ng-nb	do	148	1	3,050.00	
481	Kinabalhog	u-wh-g-nb	Tayabas	133	2	2,946.00	
482	Kinalapi	wh-ng-nb	Samar	-----	-----	-----	
483	Kinamaguian	u-wh-ng-nb	-----	145	1	475.00	
484	Kinanay I	u-wh-ng-nb	-----	137	1	2,050.00	
739	Kinanay II	l-wh-ng-nb	-----	185	6	2,585.00	
1217	Kinandang puti I	-----	Batangas	124	2	2,440.00	
485	Kinandang puti II	u-wh-ng-nb	do	119	3	943.00	Same as Agoyor
952	Kinandang puti III	wh-ng-nb	do	106	1	2,883.00	
1216	Kinandang pula	-----	do	121	2	2,327.50	
1165	Kinalabao a purao	l-g-nb	Nueva Ecija	177	3	1,807.00	
486	Kinalabao I	l-wh-ng-nb	do	158	2	2,457.00	
731	Kinalabao II	l-wh-g-nb	Laguna	148	1	2,700.00	
732	Kinalabao III	-----	Rizal	-----	-----	-----	Same as Masuey
747	Kinalabao IV	l-wh-g-nb	Sorsogon	154	8	1,286.00	
1166	Kinandang Kumpol	-----	Rizal	138	3	1,869.66	
487	Kinarayom	u-wh-ng-nb	Tayabas	132	2	2,448.00	
488	Kinastaño I	u-wh-ng-b	Zambales	130	3	3,036.00	
971	Kinastaño II	u	Batangas	133	4	2,200.25	
489	Kinastilla I	u-wh-g-nb	Tayabas	126	2	2,826.00	Same as Pulupot II, Quinastila II and Quinastila III
754	Kinastilla II	u-wh-ng-nb	Batangas	134	2	3,451.00	
755	Kinastillo	u-wh-ng-nb	do	135	2	2,905.00	
751	Kinastila I	u-wh-ng-nb	Cavite	139	1	2,310.00	
752	Kinastila II	u-wh-g-nb	Batangas	126	2	2,933.00	Same as Kinastilla, Pulupot II and Kinastila III
753	Kinastila III	u-wh-g-nb	Rizal	130	1	2,675.00	Same as Kinastilla, Pulupot II and Kinastila II
980	Kinastila IV	l-wh-ng-nb	Batangas	129	5	1,939.00	
1050	Kinastila V	u-wh-ng-nb	Laguna	121	5	1,891.40	
1167	Kinastila VI	-----	Nueva Ecija	169	4	2,407.00	
1193	Kinastila VII	-----	Batangas	128	3	1,731.33	
1169	Kinaturay	l-ng-b	Nueva Ecija	167	3	2,250.44	Same as Bansuray
1168	Kinatuding	l-ng-nb	Nueva Ecija	162	2	2,320.00	
490	Kinawayan I	u-wh-ng-nb	Tayabas	128	2	2,888.00	
938	Kinawayan II	l-wh-ng-nb	Laguna	131	7	2,996.71	
1029	Kinawayan III	wh-ng-nb	-----	147	2	833.00	
1218	Kinawayan IV	l-wh-ng-nb	Batangas	171	2	2,545.00	
978	Kiniristal	u-wh-ng-nb	do	103	2	1,288.00	Same as Buluhan and Quinabebe II
491	Kinogon	u-wh-g-nb	Tayabas	126	2	2,719.00	
1170	Kinuyapa	l-ng	Nueva Ecija	208	2	1,358.50	
492	Kimaguinquin	u-wh-ng-nb	-----	152	1	560.00	
950	Kuchure	u-wh-ng-nb	Occidental Negros	129	1	3,533.00	
493	Kuto	u-wh-ng-nb	Capiz	134	2	3,015.00	
494	Laca	u-wh-ng-nb	Occidental Negros	134	2	2,327.00	
1171	Lacatang lihim	l	Pampanga	-----	-----	-----	
495	Lacatan tago	l-wh-g-b	Tarlac	168	4	1,914.00	Same as Sta. Maria
496	Lacay a diquet	l-wh-g-b	-----	195	2	1,868.00	
957	Lagmac	u-wh-ng-nb	-----	139	1	3,950.00	
497	Laguiñgan	l-wh-ng-b	Zambales	165	4	2,186.00	
498	Laguiñgay I	u-wh-g-nb	Capiz	138	2	1,574.00	Same as Laguiñgay II and Malaguiñgay
499	Laguiñgay II	u-wh-g-nb	-----	140	1	1,810.00	Same as Malaguiñgay and Laguiñgay I
500	Lajay	r-ng-b	Nueva Vizcaya	-----	-----	-----	
1100	Lampadan or Alañgigan	-----	Pangasinan	132	3	1,582.00	

TABLE NO. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
501	Lamponaya	u-wh-ng-nb		138	2	2,510.00	
506	Lana	l-wh-ng-nb	Antique	178	2	2,915.00	
502	Lanay		Capiz				
1172	Lanca	l-g-b	Lepanto	169	3	1,161.50	
503	Lanconon	u-wh-ng-nb		141	2	1,514.00	Same as Dumpas
1101	Langauisan	u-wh-ng-nb	Mindanao	137	5	1,760.60	
1173	Lansoc	l-ng-b	do	179	3	1,623.50	
504	Lañgahid I	u-wh-ng-nb		133	2	4,314.00	Same as Sinambauan I and Sinambauan II
1030	Lañgahid II	wh-ng-nb		137	1	1,126.00	
1219	Largavida		Ilocos Norte	210	2	550.00	
505	Las Piñas	l-wh-g-nb	Zambales	128	4	2,516.00	
915	Leoncino	wh-ng-b	Paris, France				
507	Libod	u-wh-ng-nb	Albay	140	2	4,237.00	Same as Nagsanoot and Balibod
1008	Lihim	wh-g-nb	Pampanga				
508	Linacray	l-wh-ng-b		185	3	2,527.00	
509	Linion	l-wh-ng-nb	Occidental Negros	144	2	1,095.00	Same as Bulandi
1102	Linandoc	l-wh-ng-b	Mindanao	143	2	2,411.00	
1174	Linpac	l-g-nb	Nueva Ecija	187	2	1,624.00	
510	Lirio	l-wh-ng-nb	Zambales	163	1	1,490.00	
511	Loca I	u-wh-ng-nb	Capiz	137	2	1,827.00	Same as Loca II and Pulang Balat
512	Loca II	u-wh-ng-nb		139	1	2,230.00	Same as Loca I and Pulang Balat
513	Loma	u-wh-ng-nb		144	1	1,850.00	Same as Alibangnon
1245	Lubang		Bohol		1	1,517.30	Same as Balam, Binarit III, and Bulagsac I
514	Lubang I	u-r-ng-nb	Bohol	131	2	3,457.00	
515	Lubang II	l-wh-ng-nb	Albay	147	6	2,530.00	Same as Lubang III and Pauni
516	Lubang III	l-wh-ng-nb	Romblon	148	2	1,809.00	Same as Lubang II and Pauni
517	Lubang IV	l-r-ng-nb	Bohol	146	3	1,255.00	
518	Lubang V	l-r-ng-nb	Occidental Negros	140	2	1,257.20	
1103	Lubang blanco		Occidental Negros	136	4	2,346.77	
519	Lubang-luay	l-wh-ng-nb	Capiz	135	12	2,423.30	
520	Lubang pula	l-r-ng-nb	Antique	145	2	1,052.00	
521	Lubang puti	l-wh-ng-nb	Leyte	134	6	2,034.00	
927	Lukban's Chi-Rice	l-wh-ng-nb		91	3	1,016.00	
522	Maauey		Pangasinan				Same as Portoc and Quinalabao II
523	Mabolo I	l-r-ng-b	do	181	4	1,877.00	
524	Mabolo II	wh-ng-nb	La Union				
1104	Mabolo III		Pangasinan				
525	Macaanay	l-wh-ng-b	do	183	4	2,039.00	
526	Macabebe	l-wh-ng-nb	Zambales	141	6	1,905.00	
1031	Macabiag	wh-ng-b	Nueva Ecija	158			
1220	Macagargari		Ilocos Norte	219	2	1,163.00	
986	Macalma	l-wh-ng-nb	Cotabato	155	5	2,738.00	
527	Macan I	l-wh-ng-nb	Tarlac	180	13	2,708.00	Same as Macan Sta. Rita and Macan Silañgan
1049	Macan II	u-wh-ng-nb	Laguna	124	4	2,417.00	
528	Macan-aga	l-wh-ng-nb	Nueva Ecija	110	7	2,380.00	
1221	Macan barret		Bulacan	191	2	1,673.50	
529	Macan Bocaue I	l-wh-ng-b	Nueva Ecija	181	7	2,097.00	
1105	Macan Bocaue II	l-wh-ng-nb	Bulacan	175	4	2,943.74	
1187	Macan Bocaue III	l-wh-ng-nb	Nueva Ecija	163	3	1,970.00	
1222	Macan lamio	l-wh-nb-ng	Bulacan	179	4	3,145.00	
530	Macan piña	l-wh-ng-nb	Tarlac	142	13	2,513.30	Same as Dinalagang Muñoz
531	Macan Sta. Rita	l-wh-ng-nb	do	178	4	2,318.00	Same as Macan I and Macan Silañgan
532	Macan señora	l-wh-ng-nb	Nueva Ecija	165	7	2,448.70	

TABLE No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
533	Macan silañgan	l-wh-ng-nb	Tarlac	173	4	2,231.00	Same as Macan I and Macan Sta. Rita
534	Macan tago I	------	do	------	------	------	Same as Binatad
1082	Macan tago II	wh-ng-nb	do	175	------	------	
1223	Macan talunko	l-wh-ng-nb	Nueva Ecija	171	2	2,237.50	
535	Macanene I	l-r-ng-b	Pangasinan	185	3	2,440.00	
1106	Macanene II	wh-ng-nb	Nueva Ecija	167	4	2,707.00	
1107	Macanining	l-wh-ng-b	Pangasinan	169	3	2,349.00	
536	Macarañag I	l-wh-ng-b	do	145	7	1,970.00	
998	Macarañag II	u-wh-ng-b	do	139	5	1,986.00	Same as Sinan-Fabian I
1108	Macarañag III	u-wh-ng-b	Pangasinan	------	------	------	
537	Macariro	l-wh-g-b	Tarlac	179	4	2,039.00	
538	Macatlo	u-r-ng-nb	Zambales	130	2	1,724.00	Same as Dinalaga III
958	Macatibus I	u-wh-ng-nb	Occidental Negros	106	3	1,784.00	
1200	Macatibus II	------	------	116	1	2,445.00	
539	Maclat	l-wh-ng-nb	Bohol	------	------	------	
540	Madayao	u-wh-ng-nb	Capiz	141	2	1,220.00	Same as Tudlo et madayao
541	Madolao	u-wh-ng-nb	------	130	2	2,578.00	
542	Magasawang palay	wh-ng-nb	Batangas	126	2	2,578.00	Same as Dumaling Kaawa
935	Magatoma	------	Japan	------	------	------	
544	Magbaliw	l-r-ng-nb	------	120	2	1,206.00	
545	Magcarotol	u-r-g-nb	------	128	2	2,294.00	
546	Magcumpol	l-wh-ng-nb	Nueva Ecija	172	7	2,148.00	
1403	Magcumpol na paaga	------	Nueva Ecija	------	------	------	Same as Saigon V
547	Magcutay	u-wh-ng-nb	Capiz	138	2	2,568.00	
548	Magpunit I	l-wh-ng-b	Camarines	185	1	1,082.00	
549	Magpunit II	l-r-g-ñb	Rizal	180	3	3,198.00	
979	Magpunit III	wh-g-nb	Batangas	126	3	1,987.50	
550	Magsalit I	l-wh-ng-nb	Laguna	193	6	2,157.00	
1175	Magsalit II	l-wh-ng-nb	Laguna	193	3	1,951.00	
551	Magsampong I	u-wh-ng-b	Pangasinan	130	2	2,357.00	
552	Magsampong II	l-wh-ng-b	Nueva Vizcaya	152	3	1,145.00	
553	Magsanaya	u-wh-ng-nb	------	135	2	2,784.00	Same as Tabucanon I
554	Magsuhay	wh-ng-nb	Pampanga	128	1	1,535.00	Same as San Pablo I
555	Maguilom	l-wh-ng-nb	------	147	3	2,302.00	
556	Maguin-os	u-wh-ng-nb	Capiz	138	2	2,999.00	
557	Maguindanao	u-wh-ng-nb	Occidental Negros	144	1	1,565.00	
987	Magdalena	l-wh-ng-nb	Tarlac	131	8	1,964.50	
959	Magpile	u-wh-ng-nb	Cavite	147	1	3,000.00	
996	Magsangle	l-wh-ng-nb	do	126	5	2,582.00	
558	Malabage	u-wh-ng-nb	Antique	144	1	1,615.00	
559	Malaca I	l-wh-ng-b	Pangasinan	191	4	1,732.00	
560	Malaca II	l-wh-ng-b	Tarlac	207	4	1,327.00	
941	Malaca III	l-wh-ng-nb	Pampanga	129	6	2,449.83	
1224	Malaca puti	------	Tarlac	200	2	591.00	
1225	Malagkit Mohon	l-wh-g-nb	Laguna	174	2	2,531.00	
561	Malaga	l-wh-ng-b	Nueva Vizcaya	198	2	899.00	
562	Malagaya	u-wh-ng-nb	Occidental Negros	142	1	685.00	
1176	Malagkit sinablay	ng-nb	Nueva Ecija	177	2	2,531.00	
563	Malagkit	l-r-g-nb	Antique	176	2	2,315 00	
991	Malagkit kaawa	wh-g-nb	Rizal	131	4	1,761.77	
564	Malagkit de rosas	r-g-nb	------	------	------	------	
565	Malagkit macapilay cabayo	r-g-nb	Camarines	------	------	------	
566	Malagkit maglilim	wh-g-nb	------	------	------	------	
567	Malagkit pulot	u-bl-g-nb	------	143	1	1,560.00	
568	Malaguiñgay	wh-g-nb	Capiz	140	1	1,415.00	Same as Laguingay I and Laguingay II
569	Malasiao	l-wh-ng-b	Pangasinan	166	4	2,130.00	
570	Malagkit negro	l-bl-g-nb	Jolo	124	2	812.00	
571	Malay	l-wh-ng-nb	Capiz	130	6	1,883.00	
572	Malido	u-wh-ng-nb	Occidental Negros	137	6	1,738.00	

TABLE No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
1033	Malinanon	wh-ng-nb			1	373.00	Same as Busisi I and Busisi III
573	Malines	l-wh-ng-b	Tarlac	168	4	2,361.00	Same as Pinirot and Banla I
574	Maliro	u-wh-ng-nb	Leyte	136	8	1,783.28	
575	Maliw	l-wh-ng-nb	Zambales	176	13	2,237.38	
576	Malumbang	l-wh-ng-b		183	3	1,559.00	
577	Mambog I	l-wh-ng-b	Tarlac	185	4	1,932.00	
1109	Mambog II	l-wh-ng-b	Pangasinan	181	4	2,250.00	
578	Manabaco	l-wh-g-nb	Antique	189	4	2,274.00	Same as Calodo
579	Manabun-ac	l-wh-ng-nb		181	11	2,536.40	
580	Managarao I	l-r-ng-nb		147	3	2,060.00	Same as Managarao II
581	Managarao II	l-r-ng-nb	Capiz	142	2	2,937.00	Same as Managarao I
582	Manay	l-wh-ng-nb	Iloilo	189	5	2,141.00	
583	Mancasar	l-wh-ng-nb	Cotabato	178	12	2,829.00	
584	Mandigorin I	l-wh-ng-b	Pangasinan	184	4	1,855.00	
1177	Mandigorin II		Ilocos Norte	163	1	2,473.00	
585	Mandogosoc	l-wh-ng-nb	Oriental Negros	145	2	1,159.00	
1226	Mangasa I	l-wh-ng-nb	Rizal	133	2	1,667.00	
586	Mangasa II	u	Bulacan	136	4	2,404.00	
1110	Mangasa		Nueva Ecija	131	2	1,487.00	
1034	Manteca baguian	wh-ng-nb		178	1	2,266.00	
587	Magnaldan	l-wh-ng-b	Pangasinan	168	3	2,137.00	Same as Dalusong
588	Mangilala	l-r-ng-nb	Capiz	136	4	1,897.00	Same as Cotsiam
589	Mangili	l-wh-ng-nb	Nueva Vizcaya	211	1	1,139.00	Same as Quiquirin
591	Mangunidanao	u-wh-ng-nb	Capiz	143	2	1,933.00	
592	Manila-on	u-wh-ng-nb		132	2	3,701.00	Same as Tallacan
593	Maningala	u-bl-g-nb	Antique	140	1	930.00	
594	Manitay	l-wh-ng-nb		161	2	1,721.00	
595	Manteca a nalabaga	l-wh-ng-b	Tarlac	161	4	1,765.00	Same as Goyodan, Iray, and Grana II
596	Manteca a purao	l-wh-ng-b	Zambales	178	4	1,770.00	
597	Manticang bayag	l-wh-ng-b		178	2	2,627.00	
598	Manticanon	l-wh-ng-nb	Tarlac	182	12	2,972.41	
599	Manuela I	u-wh-g-nb	Capiz	135	2	1,477.00	Same as Manuela II
600	Manuela II	u-wh-g-nb		136	1	1,515.00	Same as Manuela I
601	Manumbalay I	u-wh-ng-nb	Batangas	135	3	2,250.00	
602	Manumbalay II		Occidental Negros				
603	Manumbalay III	u-wh-ng-nb	Rizal	152	1	1,195.00	
604	Maragadang	l-bl-ng-b	Albay	158	3	1,094.00	
605	Maranay	l-wh-ng-nb	Misamis	154	5	1,960.00	
606	Maribquel	l-wh-ng-b	Pangasinan	170	3	2,024.00	
607	Marigaya	u-r-g-nb	Albay	135	2	3,188.00	Same as Inarangsang
608	Marinay	l-wh-ng-nb	Antique	181	5	2,216.00	
1035	Marigondong	wh-ng-nb	Zambales	174	1	1,886.00	
609	Maro-anon	-wh-ng-nb	Antique	143	4	1,158.00	
1144	Masiksek	-wh-ng-nb	Pangasinan	191	4	1,627.00	
610	Masuliao	l-wh-ng-b	Zambales	181	4	2,108.00	
611	Matabia	-wh-ng-nb	Ilocos Norte				Same as Saysayen and Sinaba II
612	Mata-it-ibid	u-wh-ng-nb	Capiz	133	2	2,181.00	Same as Pungdol
1227	Matanubong		Ilocos Norte	212	2	338.00	
543	Mayaya tapol	u-bl-ng-nb		129	1	1,420.00	
613	Mayoro I	u-wh-ng-nb	Occidental Negros	133	1	2,900.00	
1111	Mayoro II		do	146	4	1,865.00	
1112	Melmel I	wh-ng-b	Pangasinan	199	4	1,939.00	
1113	Melmel II		do				
1114	Mendigorin	l-wh-ng-b	do	186	4	1,874.66	
1115	Mendoran	l-wh-ng-b	Pangasinan	170	4	2,089.66	Same as Banla
1185	Menita	u	Rizal	142	8	1,635.00	
1228	Mestiza		Tarlac	199	2	797.00	
614	Milagrosa		Zambales				Same as Sinibuyas I and Inaropel

TABLE No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
615	Mimioc	l-r-ng-nb	do	130	4	1,885.00	
616	Mimis I	l-wh-ng-nb	Tarlac	185	4	2,286.00	
617	Mimis II	wh-ng-nb	Nueva Vizcaya				
618	Mimis morado	l-bl-ng-b	Tarlac	175	3	1,727.00	
1116	Mimis a purao	wh-ng-nb	Pangasinan				Same as Quinalibo II
1010	Minalit	wh-ng-nb	Tarlac	180	5	2,866.80	
619	Minanteca pilit	u-wh-ng-nb	Leyte	141	8	1,843.56	
620	Minantica I	u-r-g-nb	Batangas	134	2	2,194.00	
621	Minantica II	u-wh-g-nb	Tayabas	130	2	2,613.00	Same as Iray
622	Minantica III	l-wh-g-nb	Laguna	139	3	994.00	
1117	Minantica IV	u-wh-ng-nb	Nueva Ecija	134	7	2,003.60	
1118	Minantica V	l-wh-ng-b	Pangasinan	162	4	2,302.00	
623	Minasanting	u-wh-ng-nb	Bataan	134	1	2,465.00	
624	Minatanda I	u-wh-ng-nb		125	2	2,349.00	
960	Minatanda II	u-wh-ng-nb	Cavite	128	1	3,480.00	
625	Minaya	l-wh-ng-nb		184	5	2,284.00	
626	Minindoro	l-wh-ng-b		190	4	2,121.00	
627	Ministiza	l-wh-ng-b	Nueva Ecija	179	4	2,287.00	
628	Mitao	u-wh-ng-nb	Capiz	126	2	2,837.00	
921	Miyako I	l-wh-ng-nb	Japan				
1190	Miyako II		do	94	3	354.33	
1279	Mochi		do				
630	Mole I	u-wh-ng-nb		145	2	1,950.00	
1036	Mole II	wh-ng-nb	Bukidnon	152	1	980.00	
631	Mongcol	u-wh-ng-nb	Misamis	141	1	1,300.00	
632	Morado I	l-wh-g-nb		164	1	1,104.00	
633	Morado II	l-r-g-nb	Antique	181	2	1,448.00	
634	Morado III	l-wh-ng-nb	Iloilo	148	7	1,517.00	
1229	Mudson		Ilocos Norte	221	1	466.00	
635	Mulan-ay	l-wh-ng-nb	Tarlac	143	12	2,704.30	Same as Tinagalog moro
636	Mulchion	l-wh-ng-b	Nueva Vizcaya	199	3	1,496.00	
1119	Murmuray I	l-wh-ng-b	Pangasinan	188	2	2,904.00	
1120	Murmuray II	l-wh-ng-b	do	206	2	2,446.00	
937	Murson	l-wh-ng-b	Nueva Vizcaya	208	2	738.00	
638	Nagcayat	u-wh-g-nb	Batangas	129	2	2,825.00	
639	Nagdami I	u-wh-ng-nb	Tayabas	130	4	2,696.30	
1051	Nagdami II	u-wh-ng-nb	Laguna	128	4	1,808.00	
1230	Naglihim		Batangas	140	2	2,391.00	
1231	Nagoyon		do	130	2	1,556.00	
640	Nagpilit		Tayabas				
641	Nagsano-ot	u-wh-ng-nb	Tayabas	138	6	2,209.00	Same as Balibod and Libod
642	Nagsaya	u-wh-ng-nb	Batangas	136	3	2,288.00	
643	Nagsayang mahaba	u-wh-ng-nb	Tayabas	128	2	2,608.00	
644	Nagsayang pula	u-wh-ng-nb	Batangas	132	2	1,525.00	
922	Nakamura	wh-ng-nb	Japan				
645	Nalizon	u-wh-ng-nb		133	2	1,945.00	
646	Nalmoan		Nueva Ecija				Same as Payacan
1249	Nang Lerug		Siam				
1254	Nag So						
1256	Nang Meo						
1261	Nang Be		Saigon				
647	Negro	u-bl-ng-b	Albay				
648	Niñur	l-wh-ng-nb	(Moro)	146	2	1,909.00	
916	Novarese	l-wh-ng-b	France	116	2	298.00	
1121	Nuestra Señora	l-wh-ng-nb	Mindanao	138	4	2,552.77	Same as Señorita
649	Ngirñgir	l-wh-ng-b	Pangasinan	190	4	1,549.00	
1232	Oacray			219	2	519.00	
650	Ohoy I	l-wh-ng-nb	Cebu	135	1	2,500.00	
992	Ohoy II	r-ng-nb	Occidental Negros	139	5	2,582.00	
651	Oinote	u-wh-ng-nb	Cebu	142	1	850.00	Same as Ventura
933	Omachi		Japan				
652	Onac	l-wh-g-nb	Jolo	138	2	1,154.00	
653	Ontalamis I	u-wh-ng-nb	Occidental Negros	140	1	1,350.00	
654	Ontalamis II		Capiz				
1011	Oryza manilensis (wild rice)	r-ng-nb	Sorsogon				

TABLE NO. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
655	Orpei	u-r-g-nb	Tarlac	138	1	1,225.00	Same as Taba
656	Oscuro	u-wh-g-nb		152	1	1,087.00	
657	Otia	r-g-nb	Nueva Vizcaya		1		
1233	Pagay a pinili	l-wh-g-nb	Pangasinan	155	2	1,819.00	
1274	Pahit (Str. No. 7)		Borneo				
1277	Pahit (Str. No. 3)		do				
658	Palagang a bayag	l-wh-ng-b		194	3	1,806.00	
659	Palaguinguing	u-wh-ng-nb	Antique	136	1	2,680.00	
1122	Palanta	wh-ng-b	Pangasinan	202	4	2,222.00	
660	Palaynon	l-wh-ng-nb		144	3	1,739.00	Same as Cayahan
661	Pallacate	l-wh-ng-b	Pangasinan	201	4	1,413.00	
1006	Palongpong	u-wh-ng-nb	Misamis	150	5	1,639.66	
662	Paraya	l-wh-ng-nb	Antique	150	1	672.00	
663	Pauni	l-wh-ng-nb	Tarlac	143	11	2,448.00	Same as Lubang II and Lubang III.
664	Payacan	l-wh-g-b	Pangasinan	189	4	1,279.00	Same as Nalmoan
666	Payong	l-wh-ng-nb		144	6	1,520.00	
1123	Payus	l-wh-ng-b	Pangasinan	188	4	2,331,00	
665	Payapay	l-r-ng-b	do	191	4	1,629.00	
667	Peduaanan	r-ng-nb	Nueva Vizcaya				
668	Panasil	u-wh-ng-nb	Antique	144	1	2,010.00	
1252	Phung Tiiy						
669	Pias	l-wh-ng-b	Pangasinan	176	4	1,879.00	
670	Pias a bayag	l-wh-ng-b	do	216	4	1,227.00	
1178	Piatan		Bontoc	144	4	1,490.00	
671	Pilapil I	l-wh-g-nb		182	5	2,220.00	
672	Pilapil II	u-wh-ng-nb	Cebu	139	1	1,180.00	Same as Inuay and Tahodilahas
673	Pileng baybay	u-wh-ng-nb	Bataan	139	1	1,780.00	Same as Inantipolo I
674	Pilit cayom	u-wh-g-nb	Misamis	141	1	5,240.00	
675	Pilit coricol	wh-g-nb		129	2	3,998.00	
676	Pilit inaguiw	l-wh-g-nb	Misamis	148	1	3,150.00	
677	Pilit kinarabao	l-wh-g-nb	Samar	157	1	3,253.00	
678	Pilit mantica	l-bl-g-nb	Misamis	139	2	1,235.00	
1334	Pilit morado		Oriental Negros				Same as Tungak and Caniber
679	Pilit siscuat	l-wh-g-nb	Misamis	135	1	3,010.00	
680	Pilit talo	l-wh-g-nb	do	155	1	791.00	
961	Pinalengke	u-wh-ng-nb	Cavite	144	5	1,964.00	
681	Pinamongang-tunay		Capiz				Same as Inuay
682	Pinangdan I	l-wh-ng-nb	do	136	4	1,086.00	
684	Pinangdan II	u-wh-ng-nb	Capiz	137	1	1,375.00	
1037	Pinangdan III	u-wh-ng-nb			1	1,307.00	
685	Pinanilan	l-wh-ng-nb	Zambales	156	7	1,892.00	Same as Sta. Cruz and Pinino
683	Pinañga	u-r-g-nb	Batangas	136	2	3,560.00	
686	Pinascuala I	l-wh-ng-nb		152	2	1,103.00	Same as Inudiong I
687	Pinascuala II						
1038	Pinaud	wh-ng-nb		150	1	793.00	
688	Pinias	l-wh-g-b	Pangasinan	208	4	1,668.00	
689	Pinili I	l-wh-ng-b	do	213	4	1,306.00	
690	Pinili II	l-r-ng-nb	do	148	3	2,292.00	
1124	Pinili III	l-wh-ng-b	do	205	4	2,129.00	
1179	Piniling		Nueva Ecija	138	3	1,233.66	
1180	Piniling Bertu	l-wh-ng-nb	Pampanga	180	3	2,958.66	
691	Piniling Bertu I	l-wh-ng-b	Tarlac	175	7	1,942.00	
993	Piniling Bertu II	l-wh-ng-nb	do	164	16	2,856.00	
692	Piniling Daniel	l-wh-ng-nb	do	177	3	2,790.60	
962	Piniling Baybay	u-wh-ng-nb	Bulacan	149	1	2,533.00	
1125	Pinili a biit		Pangasinan	133	3	1,912.00	
1234	Piniling Bebay		Nueva Ecija	138	2	1,386.50	
1235	Piniling Bebay	l-wh-ng-nb		176	1	2,553.20	
693	Pinino	l-wh-g-nb	Pangasinan	171	4	1,985.00	Same as Pinanilan and Sta. Cruz
1126	Pinirincesa	wh-ng-nb	Pangasinan	204	3	1,906.38	
1127	Pinirincipe	l-wh-ng-b	do	202	4	1,808.00	

TABLE NO. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
1236	Pinirincipe		Tarlac		1		
694	Pinirot	l-wh-ng-b	Zambales	170	13	2,846.00	Same as Banla and Malines
695	Pinorsigue	u-wh-ng-nb	Batangas	124	2	2,280.00	
696	Pinotíocan	u-r-ng-nb	Oriental Negros	141	2	2,420.00	
697	Pinukiutan	l-wh-g-nb	Nueva Ecija	163	4	1,166.00	
698	Pinulot	u-wh-ng	Bataan	136	1	1,640.00	
1237	Pinalinting Famy.		Laguna				
699	Pinutiucan	u-r-g-nb	Albay	136	2	2,691.00	
700	Pipino	l-wh-g-nb		198	4	1,542.00	
1128	Pinutat	l-wh-ng-nb	Bulacan	165	4	2,658.00	
701	Piracat	u-wh-g-nb	Occidental Negros	141	1	2,495.00	
702	Piroc-mata	u-r-ng-nb					
703	Pirurutong I	u-bl-g-nb	Tayabas	122	2	2,162.00	
704	Pirurutong II	u-bl-g-nb	Batangas	139	2	2,826.00	
705	Pirurutong III	u-bl-g-nb	Bataan	139	1	2,315.00	
1039	Polalante	l-wh-g-b		182	1		Same as Hermosa, Salasa, Inalasan, Diquet a Olandez, and Camiling
1185	Polike	ng-nb	Bontoc	136	4	1,517.00	
706	Polotan sa Mayobo	l-r-g-nb		152	1	1,832.00	Same as Kucong uwak
707	Porbida	u-wh-ng-nb		137	2	2,329.00	Same as Caboni
708	Portoc	l-wh-g-nb	Zambales	168	4	1,880.00	Same as Maauey, Quinalabao II
709	Portoc colorado	l-r-ng-nb	do	165	8	1,673.00	
710	Postoguer	l-wh-ng-nb		153	2	2,617.00	Same as Joani
711	Potan Tandu	l-bl-g-nb	Jolo	131	2	1,430.00	
712	Pototan	l-r-ng-b	Albay	163	3	2,267.00	
713	Pregunse I	u-wh-ng-nb	Capiz	148	2	2,392.00	Same as Guinulong
714	Pregunse II	u-wh-ng-nb	do	140	2	2,206.00	
1129	Princesa Canneng	l-wh-ng-b	Pangasinan	206	4	2,099.00	
715	Principe	l-wh-ng-b	Tarlac	219	4	1,082.00	
716	Puerto	u-wh-ng-nb	Capiz	135	2	2,084.00	Same as Diamante I
717	Pulang balat	u-wh-ng-nb	Bulacan	127	1	2,300.00	Same as Loca I and Loca II
718	Pulupot I	u-wh-ng-nb	Tayabas	138	5	1,952.00	
719	Pulupot II	u-wh-g-nb	Batangas	130	2	2,142.00	Same as Kinastila, Kinastila II, and Kinastila III
1186	Pulupot III	u-ng	do	152	1	2,360.00	
720	Pulutan I	u-r-ng-nb	Albay	139	2	2,917.00	
721	Pulutan II	u-r-g-nb	do	143	2	2,618.00	Same as Tapuy
722	Pulutan III	l-r-g-b	Camarines	164	1	1,076.00	
723	Pungdol	u-wh-ng-nb		133	2	2,864.00	Same as Mata-it-ibid
724	Putyucanon	u-wh-ng-nb	Leyte	135	8	1,936.00	
1130	Quinabatite	wh-ng-nb	Pangasinan	163	4	2,444.00	
725	Quinabayo I	wh-ng-b	Antique	140	1	1,530.00	
726	Quinabayo II	l-wh-ng-b	Capiz	146	2	535.00	
727	Quinabebe I	u-wh-ng-nb	Zambales	131	2	2,116.00	
988	Quinabebe II	wh-ng-nb	Tarlac	105	2	1,666.00	Same as Baluhan and Kiniristal
728	Quinaboy	l-wh-ng-nb	Oriental Negros	141	1	1,300.00	
729	Quinad-uas	u-wh-ng-nb	Antique	141	1	1,620.00	
730	Quinaguingking I	u-wh-ng-nb		148	1	950.00	
1027	Quinaguingking II	wh-ng-nb	Nueva Ecija	164	1	360.00	
1040	Quinaguingking Dager	wh-ng-nb		152	1	466.00	
733	Quinalibo I	u-wh-ng-nb	Bataan	140	1	2,110.00	
1131	Quinalibo II	l-wh-ng-nb	Tarlac	188	4	3,245.00	Same as Mimisa purao
734	Quinal-uay	l-wh-ng-nb	Iloilo	183	2	2,271.00	
735	Quinallos	l-wh-ng-nb	Nueva Ecija	175	3	1,715.00	

Table No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
736	Quinamalig	u-wh-ng-nb	Bataan	140	1	2,115.00	
737	Quinamatigue	u-wh-ng-nb	do	130	1	1,865.00	
738	Quinamias	l-wh-ng-nb		185	6	2,585.00	
740	Quinantores I	u-wh-ng-nb		142	1	1,594.00	
741	Quinantores II	l-wh-ng-nb		159	6	1,923.00	
757	Quinatoday I	l-wh-ng-nb	Pangasinan	165	6	2,425.00	
1028	Quinatoday II	wh-ng-nb		166	1	1,480.00	
742	Quinaoras	l-wh-ng-nb	Occidental Negros	147	2	717.00	
743	Quinaoray	u-wh-ng-nb		133	2	2,443.00	Same as Cabilao
744	Quinaoris I	u-wh-ng-nb	Capiz	141	2	2,996.00	
745	Quinaoris II		do				
746	Quinape		Leyte				
748	Quinarne	l-wh-g-nb	do	159	3	1,030.00	Same as Tinta II
749	Quinastaño	l-wh-ng-nb	Zambales	154	7	2,054.00	
750	Quinastido	l-wh-ng-b	Nueva Vizcaya	217	2	929.00	
756	Quinatia I	l-wh-ng-nb		185	12	2,866.08	
1191	Quinatia II	l-wh-ng-nb		184	2	1,780.00	
1041	Quinatoris	wh-ng-nb	Capiz	155	1	976.00	
758	Quinauris		Occidental Negros				
759	Quinimon	u-wh-ng-nb	Batangas	131	2	5,270.00	
760	Quinoto		Capiz				
761	Quinulago	l-wh-ng-nb	Camarines	139	3	617.00	
762	Quinulapo	u-r-ng-nb	Bataan	136	1	1,155.00	
763	Quinulantro	u-wh-ng-nb	Zambales	142	1	700.00	
764	Quinupang	u-r-ng-nb		125	2	2,908.00	Same as Cutsiam
765	Quiquirin	l-wh-ng-nb	Nueva Vizcaya	211		651.00	Same as Mangili
766	Quiriquiri	l-wh-ng-nb	Zambales	191	7	2,329.00	
767	Quiyandoce	u-wh-ng-nb		137	2	2,293.00	
1269	Radin Kuning (Str. No. 119)		Borneo				
1271	Radin Kuning (Str. No. 62)		do				
1272	Radin Kuning (Str. No. 3)		do				
1273	Radin Kuning (Str. No. 17)		do				
1275	Radin Kuning (Str. No. 6)		do				
1276	Radin Kuning (Str. No. 66)		do				
1255	Ramai						
1257	Ramay						
919	Ranghino	wh-ng-nb	France				
771	Reppeng	l-wh-ng-b	Pangasinan	132	6	1,308.00	
768	Romero I	u-wh-ng-nb	Occidental Negros.	143	1	1,275.00	
769	Romero II	l-wh-ng-nb	Nueva Vizcaya	196	1	1,800.00	
770	Romero III	wh-ng-nb	Samar				
1004	Roxas	l-wh-ng-nb	Bureau of Agriculture	142		2,715.00	
924	Ryuchu	l-wh-ng-nb	Formosa	128	7	2,484.14	
1238	Saan a pinili	l-wh-ng-nb	Pangasinan	155	2	1,687.50	
772	Saba	l-wh-ng-b	do	172	7	2,538.57	
1182	Sabacarra	l-ng-b	Ilocos Norte	156	3	2,364.00	
773	Saca	u-wh-ng-nb	Capiz	134	2	2,589.00	Same as Cayaya
774	Sacsek	u-wh-ng-nb	Batangas	140	12	2,002.90	
775	Sadsaran	u-wh-ng-nb	Occidental Negros				
776	Sagod	l-wh-ng-b	Zambales	157	4	1,928.00	
777	Saguboy	l-wh-ng-nb	Oriental Negros	141	2	1,400.00	
778	Saigon I	u-wh-ng-nb	Capiz				Same as Saigon II
779	Saigon II	l-wh-ng-nb	do	158	7	2,315.00	Same as Saigon I
780	Saigon III	l-r-ng-nb	Zambales	173	4	2,196.00	
781	Saigon IV	l-wh-ng-nb	Antique	162	1	3,102.00	Same as Diamante IV and Calumpit
1393	Saigon V	l-wh-ng-nb	Nueva Ecija				Same as Magumpol na paaga
782	Salacangcang	u-wh-ng-nb		143		1,160.00	
973	Salapin	u-wh-ng-nb	Cotabato				

TABLE NO. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
1042	Salasa	l-wh-g-b		190	2	1,536.00	Same as Hermosa, Inalasan, Polalante, Diquet a Olandez, and Camiling
783	Sal-laguid	l-wh-g-b	Tarlac	185	4	198.00	
784	Saloot	u-wh-ng-nb	Batangas	138	3	2,435.00	
1132	Salomanay	u	Pangasinan				
1239	Salinguyod		Ilocos Norte	219	2	466.00	
1133	Samban	u-wh-ng-nb	Mindanao	126	5	2,227.60	
785	Samberga	l-wh-g-b	Zambales	162	4	1,718.00	
786	Sambilac I	l-wh-g-b					Same as Sambilac III, Castañeda, Bisal, and Sinoyod
787	Sambilac II		Pangasinan		1		
1047	Sambilac III	wh-g-b					Same as Castañeda, Bisal, Sinoyod, and Sambilac I
788	Sambulauan	u-wh-g-nb	Oriental Negros				
789	Sampurin	l-wh-g-nb	Nueva Ecija	173	3	2,015.00	Same as Barsoñga
1134	Sampurado	wh-ng-b	Pangasinan	184	2	3,040.00	Same as Almisqui, Binalayang, and Bacal
790	Sanglay	wh-ng-b	Nueva Vizcaya				
791	Sanglay-puti	u-wh-ng-nb	Zambales	130	10	2,916.86	Same as Bulagsac II
792	Saguionan	r-ng-nb					
793	San Jose I	u-wh-ng-b	Ilocos Norte	132	2	2,564.00	
794	San Jose II	u-bl-g-nb	Capiz	142	1	1,680.00	Same as Tinta de Castilla
795	San Jose III	l-wh-ng-b	Tarlac	174	3	1,615.00	
796	San Juan I	u-wh-ng-nb	Capiz	135	2	2,262.00	
797	San Juan II	l-r-ng-nb	Cagayan	151	3	1,326.00	
798	San Juan III	l-wh-ng-b	Tarlac	185	4	1,657.00	
799	San Manuel	l-wh-ng-b	do	204	4	1,550.00	
800	San Pablo I	u-wh-ng-nb	Capiz	130	2	2,611.00	Same as Magsuhay
801	San Pablo II	u-wh-ng-nb	Antique	142	1	2,350.00	Same as Tabacanon
802	San Pablo III	l-wh-ng-nb		176	1	4,300.00	
803	San Pedro		Pangasinan	179	7	2,064.00	
804	Santa Cruz		Sorsogon				Same as Pinino and Pinanilan.
1043	Santa Maria	wh-g-b	Pangasinan	169			Same as Lacatan tago
806	Santo Niño I	u-bl-ng-nb	Albay	145	2	3,441.00	
807	Santo Niño II	l-wh-ng-nb	Zambales	174	3	2,131.00	Same as Balasang
805	Santa Tomasa	l-wh-ng-b	Nueva Vizcaya	218	2	550.00	
808	San Vicente	l-wh-ng-nb	Antique	176	1	3,300.00	
809	Sararola	u-wh-ng-nb		140	1	910.00	
810	Sasanglay	l-wh-ng-b	Albay	169	3	2,179.00	
811	Saysayen	l-wh-ng-nb	Zambales	174	13	2,412.00	Same as Matabia and Sinaba II
1183	Seda		Santo Domingo				
1188	Sekitori	ng-nb	Japan	106	3	496.00	
1135	Sempulec	l-wh-ng-b	Pangasinan	163	4	2,707.00	
1278	Seraup (Str. No. 3)		Borneo				
1270	Seraup (Str. No. 15)		Borneo				
812	Señora I	u-wh-ng-nb	Antique	142	1	2,800.00	
813	Señora II	l-wh-ng-nb	Laguna	143	13	3,065.00	
1417	Senorita						Same as Nuestra Señora
1246	Siamese "A"	l-wh-ng-nb	Siam	158	1	3,171.00	
964	Sinaba I	u-wh-ng-nb	Batangas	135	1	3,110.00	
1044	Sinaba II	l-wh-ng-nb	Zambales	167	1	1,973.00	Same as Matabia and Saysayen

TABLE No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
1136	Sinaba III	u	Pangasinan	140	4	1,597.50	
1137	Sinaba pinili		do				
963	Siany	u-wh-ng-nb	Cavite	118	1	2,600.00	
814	Sinabutan	r-ng-b	Samar				
815	Sinacoban	u-wh-ng-nb	Oriental Negros	140	9	1,930.10	
816	Sinaguing I	u-wh-ng-nb	Tayabas	128	2	3,688.00	
982	Sinaguing II	wh-ng-nb	Batangas	122	5	1,768.70	
817	Sinalapsap	l-wh-ng-b	Tarlac	165	7	1,873.00	
818	Sinambauan I	u-wh-ng-nb	Occidental Negros	135	1	925.00	
819	Sinambauan II	u-wh-ng-nb	Capiz	137	2	1,919.00	Same as Sinambauan I and Langahid
992	Sinampaga I	wh-ng-nb	Batangas				
1138	Sinampaga II		Nueva Ecija	141	4	1,671.00	
820	Sinampirit	l-wh-ng-b	Zambales	161	3	1,499.00	
981	Sinan-Fabian I	wh-ng-nb	Nueva Ecija	130	4	2,343.00	Same as Macarañag
997	Sinan-Fabian II	wh-ng-nb	Tarlac	149	5	2,427.00	
1139	Sinan-Fabian III	wh-ng-b	Pangasinan				Same as Binacroy II, Dinaluson, Daluson a Biit, and Balolaqui
821	Sinangcoban	u-wh-ng-nb	Oriental Negros	144	1	1,210.00	
822	Sinaglay Cabiitan	u-r-ng-nb	Zambales	125	2	3,023.00	Same as Binarit I and Granada
823	Sinangoyor	l-wh-g-b		165	5	2,091.00	
824	Sinibugnan	l-wh-ng-b	Nueva Ecija	170	4	2,005.00	
825	Sinibuyas I	l-wh-ng-nb	Zambales	178	7	2,155.00	Same as Inaropel
942	Sinibuyas II	l-wh-ng-nb	Bulacan	180	6	3,036.66	
1194	Sinibuyas III	l-wh-ng-nb		183	3	1,810.33	
1240	Sinibuyas IV		Tarlac	168	2	2,158.00	
826	Sinoyod	l-wh-g-b		170	3	2,299.00	Same as Castañeda, Bisal, Sambilac I, and Sambilac III
827	Sipot	l-wh-ng-nb	Laguna	138	12	2,660.30	
828	Soladon I	l-wh-ng-nb	Antique	181	10	2,594.60	
829	Soladon II	l-wh-g-nb		153	3	1,669.00	
830	Solar	l-wh-ng-b	Nueva Vizcaya	180	4	1,550.00	
831	Solarum	l-wh-g-nb	Sorsogon	144	3	2,338.00	
832	Solig I	u-wh-ng-nb	Capiz	137	2	2,287.00	
833	Solig II	u-wh-ng-nb	do	131	3	2,684.00	
834	Somarocsoc	l-wh-ng-nb	Leyte	136	6	1,163.00	Same as Cabuyo
835	Sota	l-wh-ng-nb	Iloilo	149	3	1,782.00	
836	Subaan	u-wh-ng-nb	Antique	138	1	940.00	Same as Subaan ñga Poctol
837	Subaan ñga Bohol	u-r-ng-nb	do	142		1,490.00	
838	Subaan ñg Poctol	u-wh-ng-nb	Antique	140	1	2,250.00	Same as Subaan
839	Suliog	u-r-ng-nb	Capiz	132	2	3,289.00	
840	Surat-Maya						
841	Taba	r-g-nb	Occidental Negros	135	2	2,869.00	Same as Orpel
842	Tabacanon	u-wh-ng-nb	do	139	1	1,575.00	Same as San Pablo II
843	Tabao	u-wh-ng-nb	Capiz	126	1	1,650.00	Same as Carolina Golden I
844	Tabucanon I	u-wh-ng-nb	do	137	2	2,830.00	Same as Magsanaya
845	Tabucanon II	u-wh-ng-nb	Iloilo	138	2	2,634.00	Same as Amarillo I
1045	Tabucanon III	wh-ng-nb	Capiz	149	1	718.00	
1258	Tadung						
846	Taguianan	l-wh-ng-nb	Iloilo	177	1	3,100.00	
847	Tahodilahas	l-wh-ng-nb	Occidental Negros	139	2	1,441.00	Same as Inuay and Pilapil II
925	Taka-Hoirey	l-wh-ng-nb	Formosa	139	1	3,221.00	
848	Takilid	l-wh-ng-nb		186	6	2,725.00	
926	Takon-Hoirey	l-wh-ng-nb	Formosa	138	1	3,393.00	
1189	Takenery	ng-nb	Japan	112	2	111.50	

TABLE NO. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
849	Talankao	u-wh ng-nb		140	1	353.00	Same as Calivo I
850	Talaya	u-bl-ng-nb		137	1	1,930.00	
852	Tallacan	u-wh-ng-nb		140	1	1,800.00	Same as Manilanon
851	Talonanen	u-wh-ng-nb	Antique	135	1	2,700.00	
1260	Tam Vuoc						
853	Tapol I	u-bl-ng-nb	Antique	140	1	963.00	
854	Tapol II	u-bl-g-nb	Occidental Negros	138	2	2,174.00	
855	Tapol III	u-bl-ng-nb	Oriental Negros	142	1	2,173.00	
856	Tapul I	u-bl-g-nb	Iloilo	138	3	1,867.00	
857	Tapul II	bl-ng-nb	Bohol				
858	Tapuy	u-r-g-nb	Albay	142	2	3,007.00	Same as Pulutan
859	Tarbayanon I	l-wh-ng-nb	Misamis	145	10	2,279.90	Same as Tarbayanon II and Dalua
860	Tarbayanon II	l-wh-ng-nb	do	144	5	2,474.00	Same as Tarbayanon I and Dalua
861	Tarlac	l-wh-g-b	Pangasinan	180	4	1,784.00	
862	Tayabas	u-wh-ng-nb	Occidental Negros				
863	Tayading	l-wh-ng-nb	Tarlac	199	4	1,512.00	
864	Tayading pula	l-r-ng-nb	Zambales	145	4	2,730.00	
865	Tayaring	l-r-ng-nb	do	143	3	2,870.00	
1259	Teip Huong						
866	Tenido	l-wh-ng-b	Nueva Ecija	166	4	1,837.00	
929	Thoc Him Trang	l-ng-nb	Indo-China	140	1	1,241.00	
1250	Thul Chalong						
867	Tigbauanon	u-wh-ng-nb		141	2	2,490.00	Same as Caton-og and Culaui
1140	Timanlag	l-wh-ng-b	Pangasinan	202	3	1,551.00	
868	Tinabas	l-wh-ng-nb		148	6	2,612.00	
869	Tinabuas	u-wh-ng-nb	Iloilo	135	2	2,035.00	
870	Tinabuyog	u-r-ng-nb	Antique				
1430	Tinagalog Moro		Nueva Ecija				Same as Mulanay
871	Tinalahib	u-wh-ng-nb	Batangas	140	2	3,535.00	
872	Tinambó	u-wh-ng-nb	Bataan	134	1	2,035.00	
873	Tinampucoy	u-wh-g-nb	Laguna	132	2	2,851.00	
874	Tinanod	u-wh-g-nb		141	1	1,580.00	
875	Tinanoy	u-r-g-nb	Batangas	128	2	3,543.00	
1046	Tinolamis	u-wh-ng-nb	Capiz				Same as Tulamis
876	Tinoma	l-r-ng-nb	Albay	172	2	1,456.00	
877	Tinoma blanco	u-r-ng-nb	do	141	2	2,630.00	
878	Tinoma negro	u-r-g-nb	do	137	2	3,191.00	
879	Tinomanan	u-wh-ng-nb	Oriental Negros				
880	Tinta I	u-bl-g-nb	Capiz	140	1	2,040.00	
881	Tinta II	wh-g-nb					Same as Quinarne
882	Tinta III	l-wh-g-nb		150	1	1,100.00	
883	Tinta de Castilla	u-bl-g-nb	Capiz	137	2	2,586.00	Same as San Jose II
884	Tinumbaga	u-wh-g-nb	Tayabas	131	2	3,045.00	
885	Tirana	l-wh-ng-b	Tarlac	190	4	1,752.00	
886	Tiritir	l-wh-ng-b	Pangasinan	203	4	1,452.00	
887	Tomagastos	u-wh-ng-nb		143	1	1,290.00	
888	Tomancon	l-wh-ng-nb		153	3	1,154.00	
889	Tudlo-et-Madayao	u-wh-ng-nb	Capiz	139	2	1,860.00	Same as Madayao
890	Tuguianan	l-wh-ng-nb		197	3	1,397.00	Same as Joquianan
891	Tuhao I	l-r-ng-nb	Antique	146	2	2,681.00	Same as Capacpula
892	Tuhao II	l-wh-ng-nb	do	139	4	1,487.00	
1148	Tuhao III or Caot	u	Occidental Negros	144	4	1,811.69	
893	Tulamis	u-wh-ng-nb	Capiz	136	2	1,961.00	Same as Tinolamis
894	Tumanan	l-wh-ng-nb	Romblon	153	3	1,761.00	
895	Tumatuma	l-wh-ng-nb	Jolo	158	2	306.00	
896	Tumay Tanghon	l-wh-ng-nb	Misamis	145	4	1,438.00	
1439	Tungak		Laguna				
897	Tungcadol	l-wh-ng-nb	Occidental Negros	180	2	2,840.00	

TABLE No. 10.—*List of different varieties of rice*—Continued

Permanent number	Variety name	Classification	Place of origin	Maturity in days	Number of years tested	Yield in kilos	Remarks
1241	Turo		Ilocos Norte	213	2	775.00	
1141	Ubanan	l-wh-ng-b	Pangasinan	167	3	2,080.00	
1184	Ugnas		Bontoc	135	3	1,143.66	
898	Ulian	u-wh-ng-nb			1	526.00	Same as Calaguio
899	Urtoc	r-ng-nb					
901	Ventura	u-wh-ng-nb	Capiz	138	2	1,998.00	Same as Oinote
917	Vialone	wh-ng-nb	France				
904	Vinirgen	wh-ng-nb	Camarines				
1268	Vintula						
905	Virgen	l-wh-ng-nb	Occidental Negros	184	5	2,446.00	
906	X A			136	1	520.00	
907	X B	u-wh-ng-nb		164	1	1,185.00	
908	X C	l-wh-ng-nb		117	1	1,760.00	
1142	X D-Salin	l-wh-ng-nb	Pangasinan	209	2	2,141.00	
1143	X E	wh-ng-b	Rizal				
1144	X F	wh-ng-b	Pangasinan	192	2	2,149.00	
1145	X G		do	170	1	2,942.00	
909	Yaganon	u-wh-ng-nb	Bukidnon	142	2	1,524.00	
923	Yedo	wh-ng-nb	Japan				
910	Zaragosa	u-wh-ng-nb	Pangasinan	138	4	1,585.00	
1251	(No name)						

NOTE.—u= upland; l= lowland; wh= white; r= red; bl= black; g= glutinous; ng= non-glutinous; b= bearded; nb= non-bearded.

The numbers in the first column are permanent numbers given by the Bureau of Agriculture to each variety collected and tested.

SOME MEASURES USED AND THEIR EQUIVALENTS

1 cavan (rough rice) =75 liters
= 2.128275 bushels
=44 kilos including weight of sack
=43.6 kilos not including weight of sack
= 0.4217 cubic meter (Bureau of Internal Revenue)
1 bushel =35.24 liters
1 ganta = 3 liters
= 8 chupas
= 1.744 kilos (rough rice)
1 peck = 8.810 liters
1 gallon = 3.78543 liters
= 4 quarts
1 quart (liquid) = 0.94636 liters
1 quart (dry) =1.101 liters
1 pint (liquid) = 0.47318 liters
1 barrel (bbl.) =31.5 gallons
1 cavan (clean rice) =57.5 kilos
1 ganta (clean rice) = 2.30 kilos
1 liter =1000 cu. centimeters

Some measures used and their equivalents—Continued

1 hectare =2.471 acres (English)
=10,000 square meters
=3,577 brazas cuadradas
=35.77 loanes
=3.577 balitas
=0.3577 *quiñón* (Spanish)
=100 ares
1 acre =0.4047 hectare
1 are =100 square meters
=119.59 square yards
1 centare =1 square meter
1 square meter =1,550 square inches
1 picul (Manila) =63.25 kilos
1 picul (used by Chinese dealers in measuring clean rice) =60.45 kilos
112 pounds =(cwt. long ton) =50.802 kilograms
1 kilo =2.20462 English pounds
=2.174 Spanish pounds
1 pound (avoir.) =453.59 grams
=16 ounces
1 ounce (avoir.) =28.35 grams
1 gram =15.43 grains
1 mile =1609.35 meters
=5,280 feet
=320 rods
1 chain =20.12 meters
1 rod =5.03 meters
1 braza =2 yards
1 yard =0.914402 meters
1 foot =0.30 meters
1 inch =0.0254 meters

THE RICE BUG, *LEPTOCORISA ACUTA* THUNBERG, IN THE PHILIPPINES

By LEOPOLDO UICHANCO

INTRODUCTION

Of the insect enemies of rice, there is probably none that is so well-known among the Filipino planters as the rice bug (*Leptocorisa acuta* Thunberg). Here, as in other neighboring rice-growing countries, the damage done by this insect to the rice crop is considerable, especially during the months of its greatest abundance, when it destroys at times over one-half of the season's crop. For want of a satisfactory method for the control of this pest, the farmers very often find themselves helpless when this very injurious insect appears in great numbers in their fields.

SYSTEMATIC CONSIDERATIONS

Leptocorisa acuta belongs to the family *Coreidae,* subfamily *Alydinae,* tribe *Leptocorisaria,* and suborder *Heteroptera,* of the order *Rhynchota* or *Hemiptera.* The genus is a widespread one, with species representing it in all parts of the world. In the Philippines, fifteen years of insect collecting by the Bureau of Science from all parts of the Islands, and four years of field observation by me at Los Baños and the neighboring localities led only to the capture of a single species—*L. acuta.* Stal (10)[1], however, writing in 1870, reports *L. varicornis* Fabr. as occurring in the Philippines, although, judging from the descriptions furnished by Distant (2), the characters given for *L. acuta* and *L. varicornis* do not seem to have differences important enough to separate the two insects into distinct species. For example, the color characters made use of by Distant to distiguish these species do not appear to be a sufficiently safe guide, as in pinned specimens there is likely to be some variation in color shades, even of insects of the same species, due to the differences in conditions to which they may have been subjected. The other differences pointed out by Distant appear to be too slight to make one of these "species" more than a variety of the other.

Professor C. F. Baker states that he sent a collection of specimens of different species of *Coreidae,* for study, to Bergroth in

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[1] Refers to Bibliography at the end of this article.

Finland. These specimens comprise species collected from all over the Philippines, and also from China, Borneo, and Singapore. As soon as the report is received from Bergroth, this apparent confusion in nomenclature may be cleared up.

DIALECT NAMES IN THE PHILIPPINES

The rice bug is known in various parts of the Philippines under popular names which are very similar to each other in the different dialects. Neighboring tribes, such as Ilocano, Ibanag, and Zambal, which have noticeably different dialects, have the same name for the rice bug, while others that are more remote use terms which, due to their very close resemblance in sound to those employed in the other parts of the Islands, can be readily understood in almost any province. The following is a list of common names for the rice bug in some of the principal dialects spoken in the Philippines:

Tagalog (in practically all Tagalog provinces), *atañgia.*
Bicol, *tayañgao.*
Visayan (Cebu and Iloilo), *tiañgao.*
Visayan (Northern Mindanao), *piañgao.*
Pangasinan, *dañgeo* or *dañgueo.*
Pampanga, *dañgo.*
Ilocano, Ibanag, and Zambal, *dañgao.*
Moro (Surigao), *maradiao alebangbang.*

DISTRIBUTION

Leptocorisa acuta is of general occurrence in the Philippine Archipelago, and causes a great deal of damage in every rice-growing province. It is also known in India (2, 7, 9), China (1, 9), Java, where it is called *walang sangit* (1, 4, 5), Celebes (1), Sumatra (1), Sunda Isles (9), Borneo (1), and Australia (1, 9). No report was available from Japan at the time of this writing,[1] but is very likely that this insect is present also in that country.

PREVIOUS WORK ON THE SUBJECT

So far as I was able to ascertain, practically no biological work on the rice bug in the Philippines has appeared in print up to this time. In 1911, Zamora (13), then an undergraduate student in economic entomology of this College, published a short account of this insect, and from time to time, notes, mostly touching on control measures, have appeared in the daily and weekly press of Manila, obviously from data furnished by the Bureau of Agriculture, in the PHILIPPINE AGRICULTURAL REVIEW (6) and in the *Philippine Agriculturist* (12). The life history of

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[1] This article was submitted for publication in *the Philippine Agricultural Review* sometime in 1919. Ed.

Leptocorisa acuta has been worked out to some extent by Zehntner (14), in Java and on his paper was greatly based the biological notes which Koningsberger (4), published in 1903, in a bulletin that was evidently intended for popular perusal by the planters in the Dutch East Indies. In 1908, Maxwell-Lefroy (7) published a paper based on his biological work on *Leptocorisa varicornis* in India. This publication contains fairly complete biological notes and discussion of control measures applicable to Indian conditions.

OBJECT OF THE PRESENT WORK AND METHODS USED

The present work is the result of over two years' biological observations on *Leptocorisa acuta* in the College and privately owned farms at Los Baños, and in the neighboring fields at Calamba, Cabuyao, Santa Rosa, and Biñan, and eight months of laboratory experiments done in the Department of Entomology of the College of Agriculture. Field inspections were usually made early in the morning or late in the afternoon, although visits were made at other hours in order to find out the behavior of the nymphs and adults during the hotter parts of the day. The eggs collected in the field were confined in Petri dishes to allow the nymphs to hatch for life history work and for the collection of egg parasites that might emerge. On hatching, the nymphs were carefully transferred by means of a camel's hair brush to battery jars covered at the tip with fine muslin which was firmly held on by rubber bands. The bottom of the jars were covered with paper to collect the exuviae and excreta. Young rice panicles of which the grains were just beginning to attain the milk stage were given to the newly hatched nymphs for food. To prevent their drying up too soon, the lower, or cut, ends of these panicles were submerged in water which was contained in small bottles with loose plugs of cotton wadding at the mouth. In view of the tendency of the rice grains to dry up quickly, the feed was changed at least once a day.

Since, even in the case of the nymphs which hatch at the same time, the subsequent ecdyses do not take place simultaneously, it was found advisable to confine each nymph under observation for periods of stadia in a separate battery jar. This procedure simplified the operation of keeping track of moltings, and at the same time rendered the chances of making more accurate and reliable data greater. The exuviae were removed as soon as these were found in the battery jars, and the papers covering the bottom of the vessel changed from time to time.

During the very dry, hot months it was found necessary to suspend in the battery jars pieces of wet blotting paper. These kept the temperature down considerably, prevented the rice panicles from drying up too quickly, and surrounded the developing nymphs with an adequate amount of moisture.

Precautions were taken against ants by having a breeding shelf made with the legs standing in shallow vessels of water with a little petroleum on the surface. Rats at one time disturbed the cultures by breaking through the muslin covers of the battery jars and eating the young rice grains. This enabled the adult insects and even the nymphs to escape through the apertures thus made.

GENERAL FIELD OBSERVATIONS ON THE RICE BUG

During the cooler parts of the day, early in the morning and late in the afternoon, the insects, adults, as well as nymphs, may be found on young rice panicles. At about noontime the insects seek refuge from the intense heat of the sun on the lower parts of the plants, especially among the leaf bases.

Although a number of individuals may at times be found on a rice panicle, *Leptocorisa acuta* has never been observed to be gregarious in any of its stages. It has been noted in field inspections that the adults of the rice bug were in almost all cases more abundant than the nymphs in the rice fields. In a survey made in November, 1918, there were found on a rice field of the College about one nymph to ten adults.

EFFECT OF SEASON ON THE ABUNDANCE OF *LEPTOCORISA*

Leptocorisa acuta was observed in the College farm to be present in fairly large numbers in all stages of growth in August, September, and October, very abundant in November, and quite numerous in December. The months of November and December represent a period when the rainy-season rice is in the milk stage. In January, suitable food for the bug is rather scarce, and, as was the case this year, that month is usually characterized by extreme dryness and high temperature, which tend to render conditions unfavorable to the insects. In the laboratory, during January, 1919, it was impossible to keep the nymphs in the first and second instars alive without suspending in the battery jars wet pieces of blotting paper. These rather severe natural conditions undoubtedly accounted for the scarcity of the rice bug during this and the two or three succeeding months.

The dry-season rice, which attains the milk stage in about March and April until the earlier part of May, was found to be less attacked by the rice bug than the rainy-season rice. The months of March and April are usually very dry and hot—uncomfortably hot for most animals and undoubtedly fatal to many insects, especially in their younger stages. In my field inspections made at Bay, Calamba, Cabuyao, and Santa Rosa, during the later part of March, 1919, only a few adult rice bugs were found. Neither nymphs nor eggs were collected.

MANNER OF FEEDING AND NATURE OF INJURY

The rice bug in all stages of growth after hatching from the egg is capable of doing damage to the rice grains. The insect feeds by inserting a part of its proboscis into the interior of the rice grain in the milk stage through a weak spot at the place where the edges of the large glumes meet to form the hull. The process of feeding is briefly described as follows: The insect walks about among the grains, trying the different parts of the hull with the tip of its haustellum as it moves along. Sooner or later a place at the junction of the glumes is located and the insect stands motionless for a while, holding the haustellum at right angles with the body. After about fifteen minutes, the labium is shortened by its first and second segments forming an angle, with the vertex pointing caudal. This action pushes the maxillae and mandibles forth into the interior of the grain. Then follows a successive dorso-ventral rocking motion of the body of the insect with the pivot at the caudal portion of the abdomen. The purpose of this motion is apparently to introduce the feeding tubes into a continuous new supply of fresh materials in the grain. The feeding operations on one grain of rice by the adult was found in the laboratory to last over one hour. The following is a record of feeding of a female specimen on a rice grain, observed on February 27, 1919:

5.03 p. m.—The insect was exploring the grains on the rice panicle.
5.04 p. m.—Motionless; the tip of the haustellum was directed toward a grain.
5.15 p. m.—First and second labial segments began to form an obtuse angle.
5.19 p. m.—Angle became more acute; rocking movements of body began.
6.17 p. m.—Feeding ceased.

The effect of feeding does not immediately become apparent on the rice grain. The diffuse yellowish brown spot on the hull which marks the place where the insect inserted its haustellum for feeding does not appear until after a few days. The spot increases in size as the grain grows older. The grain thus attacked does not form any kernel and although it may finally attain its normal size, it is composed of an empty hull. It is not definitely known whether the formation of the kernel is inhibited as a direct result of mechanical injury caused by the sucking of the sap or is consequent on the injection of some enzyme or other deleterious substances into the interior of the grain during the act of feeding. The grains that show external signs of having been previously attacked by the rice bug, possess a bitter, or otherwise disagreeable taste, which seems to point to the fact that some factors other than mere mechanical injury must have contributed to bring about these pathological results.

The work of *Leptocorisa acuta* is likely to be confused with that of the paddy borer, *Schoenobius incortellus* Walker, since the latter also causes emptiness of grains. But the main point of distinction is that in the case of the paddy borer, the grains on the entire panicle are empty and are of a uniform pale straw color, while the rice bug, on account of its habit of feeding, produces empty grains only here and there in the panicle, the rest developing to normal kernels. Furthermore, the work of *Leptocorisa,* as stated before, shows the characteristic yellowish brown spot at the place where the insect inserted its mouth parts.

ECONOMIC IMPORTANCE

In its ability to cause damage on the rice plant in the Philippines, *Leptocorisa acuta* is probably equalled by no other insect, although in certain localities *Schoenobius incortellus* very often occasions greater injury. So big is the rice bug's toll on the rice crop that in such provinces as Tarlac, the people consider this insect as a worse pest than locusts (6).

As may be inferred from the discussion in the earlier part of this paper, the rice bug causes its greatest damage on the rainy-season crop of rice. Farmers at this season frequently lose as high as 50 per cent, and in certain cases more, of their total harvest as a result of the insect's depredation.

Too early planting has been found to result in heavy loss from the attack of *Leptocorisa.* Mr. Pedro Ramos, a planter at Bay, Laguna, informs me that in the rainy-season planting in 1918, he planted rice in August, a few weeks ahead of the other planters in the locality, who did not begin to plant rice until the latter part of September or the first part of October. His idea was to take advantage of the irrigation water, which he could divert entirely to his own use while the other farmers were not working their lands. His rice came to head much earlier than the others and, as might be expected, found a central focus of attraction for the rice bugs present in that place. As a result, he harvested only 40 cavans of rice from his land, as compared with 140 cavans from the same area at that season during the previous year, when he had planted at the same time with his neighbors. He, therefore, sustained a loss of over 70 per cent from the attack of the rice bug as a result of too early planting. Mackie (6) observes similar results in connection with quick-maturing varieties of rice when these are planted with those that mature later. He advises delaying the planting of the earlier maturing varieties so that their heading time will coincide with that of the latter ones.

SUSCEPTIBILITY OF DIFFERENT RICE VARIETIES

For the rainy-season planting in 1918, the Department of Agronomy of this College planted several different virieties of rice side by side on the irrigated area north of the main road. This gave me an opportunity to watch to some extent the amount of injury done by the rice bug on the different varieties. For certain reasons, it was not possible for me to obtain exact data on the effect of the work of the insect on the yield of each of these rices; but a survey made of the plants on the field at different times during the period when they were in head made it apparent that certain varieties were more preferred by *Leptocorisa* than others. The Binicol variety, for example, was found during its milk stage to be swarming with rice bugs, while varieties, then in the milk stage also, did not harbor so many insects. While the preference of the bugs for Binicol may be due to its sweeter taste and its possession of a characteristic pleasant aroma, still some other reasons suggest themselves, as, for example, the more fragile condition of the junction of the edges of the two large glumes composing the hull, which renders penetration by the mouth parts of the insect easier.

Most of the varieties of bearded rice were found to be almost immune from the attacks of the rice bug, the beards in this case probably serving as a protective deterrent to the approach of the insects. There is also the additional fact that the hull of these varieties is usually tougher and the glumes more firmly joined at the edges.

The question of degree of susceptibility is one that requires a thorough study. The different varieties that are found to be less liked by the rice bug should be sorted out and, if possible, investigations as to the reasons for their comparative immunity should be made. It is not unlikely that from the varieties thus collected systematic breeding work based upon the characteristics which may have been found to render them less susceptible might result in the production of an immune or practically immune strain or variety, and thus furnish one satisfactory means of preventing the loss from this pest.

PERIOD OF SUSCEPTIBILITY OF THE RICE GRAIN

Leptocorisa can injure the rice grain only when the latter is in the milk stage. The insect leaves the flowering panicles untouched, while the mature grain is impenetrable to its haustellum, besides the fact that they no longer contain available sap for its food. The following data with reference to rice in its different stages were furnished to me by Juan Cabanos, a thesis student working on rice in the Department of Agronomy of this College:

Length of time in seed bed	days	30 to 50
Transplanting to blooming	do	115 to 138
Blooming to heading	do	6 to 14
Heading to maturity	do	about 30

By "blooming" is meant the stage when the rice plants are in flower, and "heading" represents the stage when the grains are in milk. It is evident from the above figures that the more quickly maturing varieties do not become susceptible to the attack of the rice bug until they are about 150 days old; the late maturing ones, about 200 days. The milk stage lasts about thirty days, or one month, this being the length of time during which the plants should be protected from the rice bugs.

FOOD PLANTS

During the months when rice is not growing or when this plant is not in the milk stage, *Leptocorisa acuta* subsists on wild grasses. The insect, however, apparently prefers rice to any of its other food plants and readily migrates over to this grain whenever it is available.

In August, 1917, I observed on the College farm numerous adult *Leptocorisæ* on the panicles of *Panicum flavidum* Retz, which covered an area of about 50 square meters. There were no rice plants in the immediate neighborhood of this wild grass, and a number of individuals were actually observed feeding on the young grains.

In June and July, 1919, numerous adults were observed on the panicles of *Panicum colonum* Linn., a number of individuals having been actually feeding on the young grains of this wild grass. As in the case of *P. flavidum,* rice was not growing in the immediate vicinity. The insects were apparently healthy and normal in size. Thirteen eggs were found on a blade of this grass on July 10, 1919. It was also noted that where *P. flavidum* and *P. colonum* were growing together on the same area, the preference of the insect was always for the latter species, due undoubtedly to its comparatively more succulent grains.

On June 20, 1919, five nymphs, apparently of the first instar were found feeding on a young panicle of *Digitaria consanguinea* Gaudich in a field which was quite distant from any rice plantation.

Leptocorisa acuta has been reported by Zamora (13) feeding on *Citrus* (species not mentioned); and in July, 1916, I observed a mass of eggs of this insect laid on either surface of a leaf of pomelo, *C. decumana* L. In January, 1919, Severino Aquino, an undergraduate student in economic entomology and assistant in this Department, brought to the laboratory a leaf of *Phytolacca dioica* Linn. with three chorions of *L. acuta.* On January 13 and 17, 1919, experiments were made with *Citrus decumana* and *Phytolacca dioica,* respectively, to determine whether they would serve as food plants for the rice bug. It was found that the newly hatched insects confined with these plants did not increase in size, as they always do after remaining for about one day on young rice panicles, and on the third day all the nymphs were found dead at the bottom of the containing glass jars, apparently from starvation. This fact tends to show that neither *Citrus decumana* nor *Phytolacca dioica* can be used by the rice bug as food, and that the eggs found on the leaves of these plants were probably the results of accidental oviposition.

Writing in 1908, Maxwell-Lefroy (7) reports the following food plants of *Leptocorisa varicornis* in India: *Panicum frumentaceum* Roxb., *Eleusine coracana* Gaertn., *Andropogon sorghum* (L.) Brot., *Pennisetum typhoideum* Rich, and *Setaria italica* (Linn.) Beauv.

Experiments were conducted with nineteen species of grasses, many of which represent the more common weeds found in the rice fields at Los Baños and vicinity. The specific determinations were mostly made by Mr. E. D. Merrill, botanist[1] of the Bureau of Science, Manila. Almost all of these grasses grow and produce seeds during the entire year, and some species of these undoubtedly furnish food to the rice bug when rice is not to be found.

In the present tests about ten newly hatched nymphs were used for each grass. As in the case of rice, the food materials were changed quite frequently. The results are summarized in Table I.

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[1] Now Director.

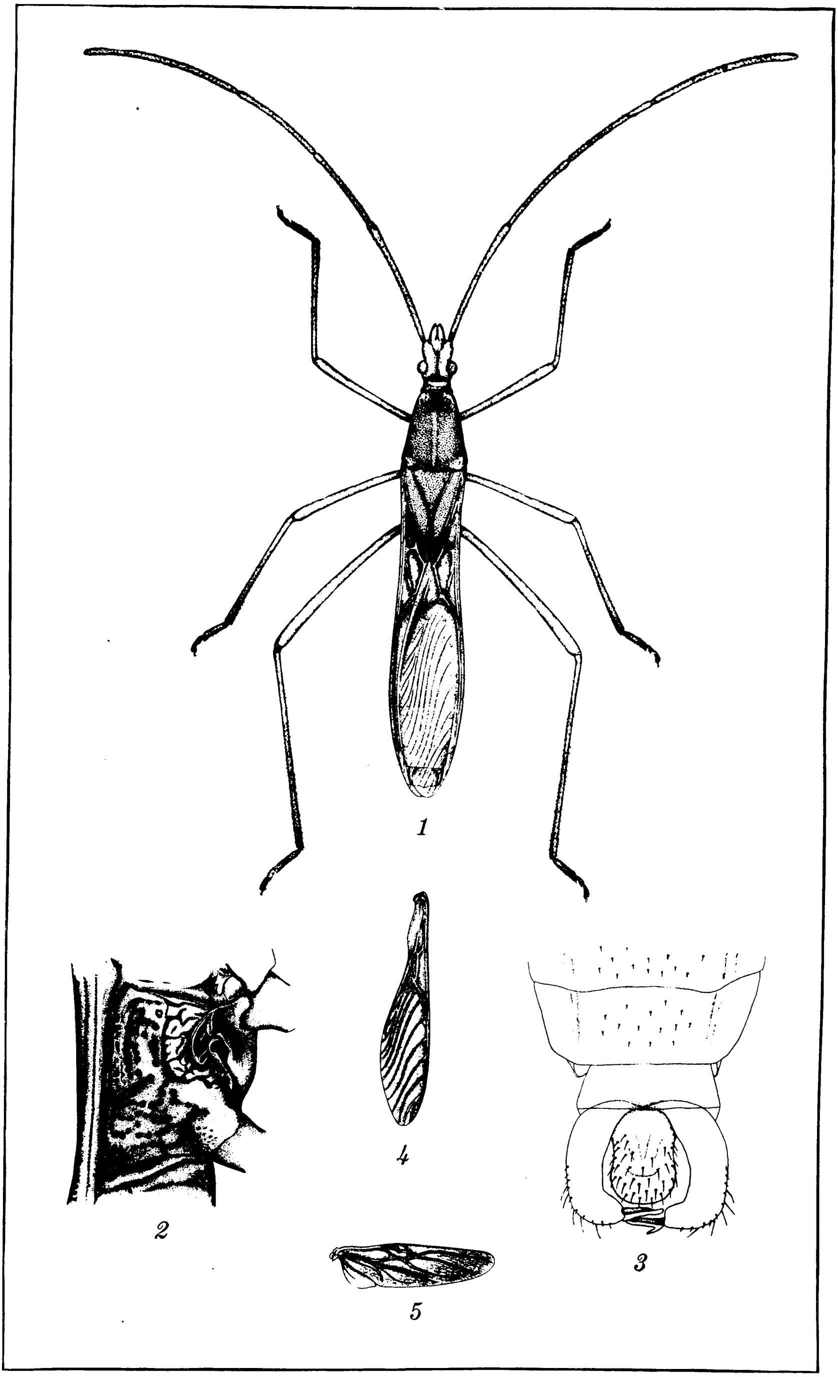
TABLE I.—*Results with wild and other grasses*

Culture No.	Name of grass	Date begun	Date of death of last insect	Number of days on the feed	Stage of insect at death
46	Panicum colonum Linn. Panicum flavidum Retz.	17-XII-18	26-III-18	99	Adult.
56	Panicum crus-galli L	13-I-19	Escaped, 14-II-19	--------	Adult.
59	Paspalum conjugatum Berg	15-I-19	5-II-19	21	Third instar.
60	Digitaria consaguinea Gaudich	15-I-19	20-IV-19	95	Adult.
61	Panicum barbinode Trin	15-I-19	29-I-19	14	Second instar.
62	Dactyloctenium aegypticum Willd	15-I-19	27-I-19	12	Second instar.
63	Eleusine indica Gaertn	15-I-19	23-I-19	8	Second instar.
64	Cyperus iria L	15-I-19	23-I-19	8	Second instar.
65	Kyllinga monocephala Rottb	15-I-19	18-I-19	3	First instar.
67	Chloris gayana Kunth	16-I-19	19-I-19	3	First instar.
68	Cynodon arcuatus Presl	16-I-19	18-I-19	2	First instar.
69	Panicum reptans L	16-I-19	31-III-19	74	Adult.
70	Cynodon dactylon (L.) Pers	16-I-19	27-I-19	11	Second instar.
71	Andropogon sorghum (L.) Brot	16-I-19	21-I-19	5	First instar.
72	Panicum patens L	16-I-19	19-I-19	3	First instar.
73	Oplismenus compositus Beauv	16-I-19	19-I-19	3	First instar.
74	Scleria scrobiculata Nees	16-I-19	19-I-19	3	First instar.
75	Panicum carinatum Presl	16-I-19	25-I-19	9	Second instar.

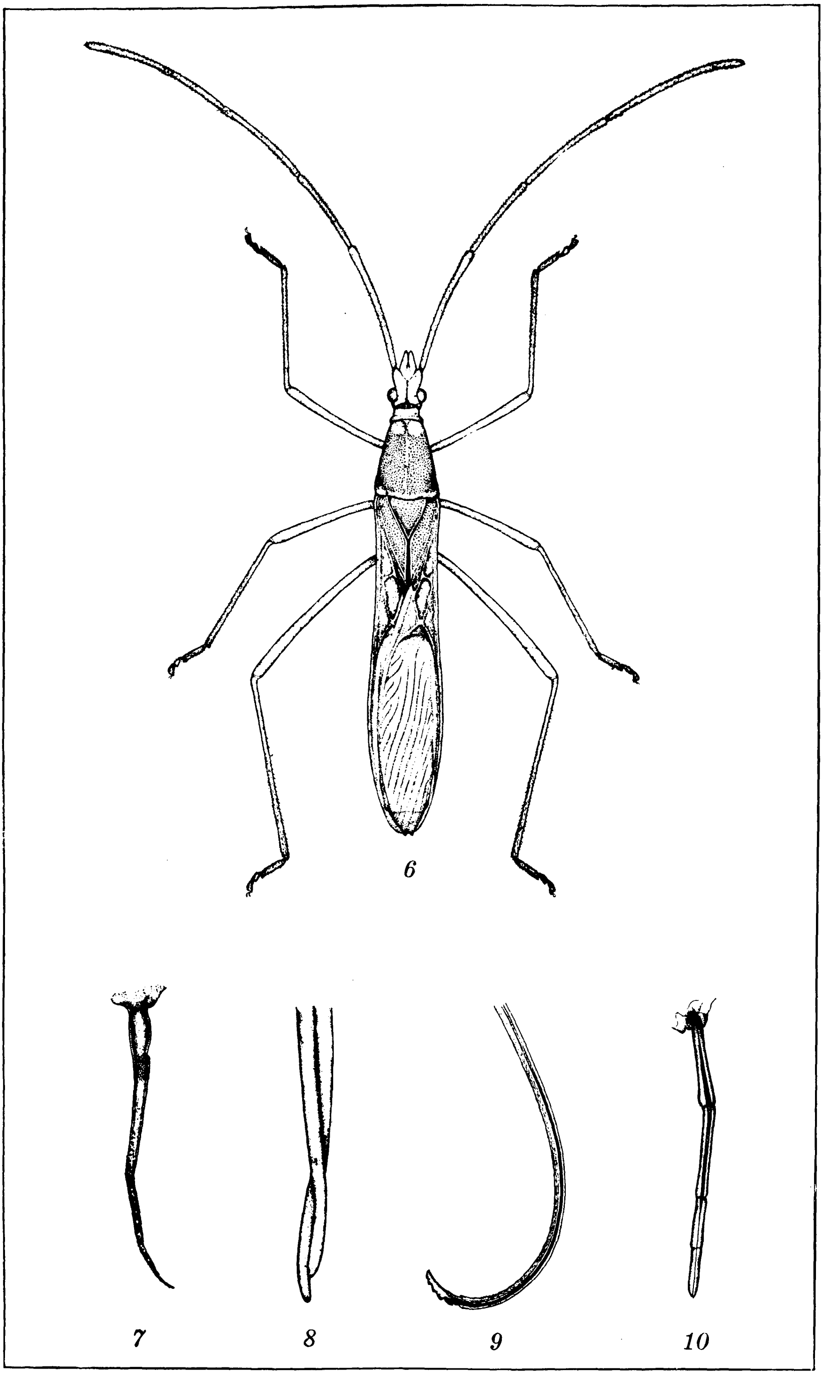
It will be noted on examination of the above table that five grasses, *Panicum colonum* Linn., *Panicum flavidum* Retz., *Panicum crus-galli* L., *Panicum reptans* L., and *Digitaria consanguinea* Gaudich, served as suitable food plants for *Leptocorisa.* The insect confined with these grasses were apparently healthy throughout the progress of the experiments. In all cases they reached the adult stage, copulated, and laid eggs.

Andropogon surghum, which was listed by Maxwell-Lefroy as a food plant of *Leptocorisa varicornis* in India, did not seem in the present experiments to furnish suitable food material for *L. acuta.* The following grasses, as shown in Table I, have been found in the laboratory to furnish satisfactory food for the rice bug to the extent of enabling the insect to molt to the second or third instar in the nymphal stage; *Paspalum conjugatum* Berg., *Panicum barbinode* Trin., *Dactyloctenium aegypticum* Willd., *Panicum carinatum* Presl., *Cynodon dactylon* (L.) Presl., *Eleusine indica* Gaertn., and *Cyperus iria* L. I am not ready at this time to state definitely that these latter grasses are less suitable as food for the rice bug than the other five previously named. The cause of the premature death of the nymphs might have been due to factors other than unsuitability of the feed; for the experiments were conducted during January, 1919, a period which, as stated previously, was a most unfavorable one for *Leptocorisa,* particularly in its younger stages.

The present experiments were not comprehensive enough to enable the drawing of a dividing line between grasses which serve as food for the rice bug and those that do not; but they do point to the fact that certain species of wild grasses serve as



1. *Leptocorisa acuta* Thunberg. Adult male; 2. Metathorax of male, dextral view, showing odoriferous gland; 3. Abdomen of male; upper view of caudal segments, showing genitalia; 4. Right hemelytron of male, ectal aspect; 5. Right metathoracic wing of male, ectal aspect.



6. Adult female; **7.** Labrum of male; **8.** Smooth setæ of male, distal portion; **9.** Barbed setæ of male, distal portion; **10.** Labrum of male.

satisfactory food material for the insect. It is important that emphasis be laid on this remark, as in a great many of our rice fields in the Philippines, weeding is not practiced carefully enough and cultivation is unfortunately often left half done. The field is frequently allowed to run to wild grasses after the rice crop is harvested and in cultivating the land for the following season's planting, the dikes of the irrigated areas and the borders of the unirrigated are not touched at all. Under these circumstances, ideal breeding places for the rice bug are preserved year after year.

DESCRIPTIONS

ADULT MALE

Length, 15.5 to 16 millimeters. General color, brownish olivaceus. Head, two-thirds as long as pronotum; thorax, two-thirds as long as abdomen. Hemelytra extending by about one millimeter beyond caudal end of abdomen. Body thickly punctate, sparsely and briefly pubescent.

Head about twice longer than broad; a depressed median line extending from the front of ocelli to base of tylus. Tylus and juga porrect; the former about one-half as long as latter, acutely pointed distad; juga irregularly subconical, broadly rounded distad, subapical ental margins connivent. Eyes dark brown, moderately large, subglobose, set lateral midway between bases of antennal tubercles and caudal margin of head. Ocelli two, brownish red, shiny, prominent, about one-tenth the size of the eyes, arranged transversely near anterior margin of head, separated by a distance subequal to the broader diameter of one of the ocelli. Antennae subequal in length to the body; Segment IV slightly longer than I; I slightly longer than III; II two-thirds as long as III; I about one and one-third times the diameter of the other segments; II, III, and IV subequal to each other in diameter; I conspicuously incrassate distal, uniformly yellowish brown; II slightly incrassate distal, basal fourth brownish yellow, the rest dark brown; III slightly incrassate distal, basal fifth brownish yellow, the rest dark brown; IV subconical distal, basal fourth and a small apical portion brownish yellow, the rest paler brown than the other segments. Haustellum extending to the middle of mesothoracic coxae; subuniformly light greenish brown except at sutures and at apical half of Labial Segment IV, which are dark brown. Labrum slightly longer than Segment I of labium, dark reddish brown, slender, very acute apical. Maxillae and mandibles dark brown, setaceous, subequal in length to labium.

Segments I and II of labium subequal in length; III about half as long as either I or II; IV about half as long as III; I open at suture; the other segments closed; I, II and III subcylindrical; IV subconical, acutely pointed apical.

Thorax about twice as long as the width of either the meso- or metathorax. Sternites and pronutum very coarsely punctate. Meso- and metathoraces and caudal margin of pronotum subequal in width; prothorax attenuate cephalad, the cephalic margin subequal in width; to caudal margin of head. Pronotum subtrapezoidal, the anterior margin being one-half the width of the posterior corners rounded; a slightly conspicuous, irregular tubercle at each caudal angle.

Scutellum triangular, concolorous with pronotum; sides bounding the caudal angle about one and three-fifths as long as cephalic margin; length of scutellum, one and one-half that of pronotum. Hemelytra about one and one-third as long as abdomen; hind wings subequal in length to abdomen. Corium and clavus thick and opaque, concolorous with pronotum, roughly punctate; inner angle of corium less opaque, dark yellowish brown; membrane thin and membranous, very slightly silvery brown. Hind wings light silvery brown, transparent; veins irregularly dark brown. Hind legs slightly longer than body; fore and middle legs subequal in length; hind legs about one and one-half as long as either the fore or the middle, in all legs: coxae irregularly subconical, yellowish brown; trochanter. brownish green; femur subequal in length to the corresponding tibia of each leg; distal portions of femora about one and one-third larger in diameter than proximal; the former yellowish brown; the latter light green; tibiae about one-half in diameter to that of distal portion of femur, of uniform thickness throughout, yellowish brown, more darkly so distal; tarsi three: I yellowish brown, more darkly so distal over one and one-half as long as II and III combined; II yellowish brown, more darkly so distal, slightly shorter than III; III dark brown, less so proximal, slightly arched subapical; ungues, black, broadly arched, about as long as Tarsal Segment II. Odoriferous apertures two, one on each side of metasternum, anterior to hind coxae, consisting of a hollow, transverse organ two and one-half times longer than its largest width, rounded dorsal, and acutely pointed and conspicuously inclined caudo-ventral.

Abdomen about four times longer than broad, subequal in width throughout, slightly tapering caudal, with the caudal end subrectangular from above. Tergites reddish brown, plane, non-pubescent. Connexivum greenish olivaceous, thinly compressed dorso-ventral, obtusely flexed upward. Sternites convex, concolorous with connexivum, pubescent, more densely so caudal. Genitalia subequal in length to antepenultimate segment. Genital forceps subconical, concolorous with connexivum, incurved distal. Anal valve subconical, diameter one and one-half that of forceps, concolorous with abdominal tergites.

ADULT FEMALE

Hemelytra with apices extending only as far as distal extremity of abdomen. Abdominal caudal abruptly subconical; caudal margin of terminal segment sharply concave. In other respects similar to male.

EGG

Length, 3.5 millimeters; width, 2.5 millimeters; hemiellipsoidal; the upper part plane or slightly concave; the lower convex; general color dark reddish brown; surface shagreened; a small, white wax-covered spot at one end.

CHORION

Opening is made from white wax-covered spot of egg (*supra*), thence along lateral border of plane or slightly concave upper surface, and ending transversely midway on upper surface of shell. Cut edges of chorion smooth, moderately thick, of uniform thickness throughout. Outer surface shagreened, dark reddish brown; inner surface, slightly shagreened, light yellowish brown.

FIRST INSTAR

First Day

Length, 1.5 millimeters. General color yellowish green; a broadly linear, yellowish brown mark from base of antennal tubercle to eye and in line with this from opposite side of eye to prothoracic coxa; thence, the line breaks slightly ventral and continues lateral to base of metathoracic coxa. Appendages dark reddish brown. Head, thorax, and abdomen subequal in length. Body and appendages sparsely covered with rather long stout pubescence.

Head elongate; slightly attenuate toward cephalic margin. Tylus and juga porrect; the former slightly longer than the latter. Tylus rounded apical; beset at apex with rather long hairs. Juga subconical apical, non-pubescent. Antennae about three times as long as body, four-segmented, sparsely covered with rather long hairs, more thickly and briefly pubescent at Segment IV; I and III subequal in length; II three-fourths as long as either I or III; IV one and one-half times long as III; I subcylindrical, abruptly incrassate distal, uniformly dark reddish brown; II subcylindrical, light greenish, except a small portion distal and larger portion proximal, which are dark reddish brown; III subcylindrical, slightly incrassate distad, piceous; IV subcylindrical, attenuate apicad, reddish brown, with subbasal half and a small portion apical brownish yellow. Eyes hemispherical, red, set lateral midway between cephalic and caudal margins of head. Haustellum one and one-fourth as long as body. Labrum pale yellowish brown, slightly longer than Segment I of labium. Labium dark reddish brown, except Segment I, yellowish; I, II, and IV subequal in length; III slightly shorter; I subcylindrical, abruptly incrassate distal; II subcylindrical, moderately attenuate distad; III subcylindrical, conspicuously incrassate distad; IV obovoid, distal portion acutely pointed, proximal portion moderately attenuate.

Thorax uniformly subequal in width to caudal margin of head, about one and one-half times longer than broad; pro-, meso-, and metathoracic segments subequal in length. Wing pads not evident. Fore and middle legs subequal in length to the body and to each other; hind legs slightly longer; the three pairs sparsely beset with moderately long pubescence, more densely so at tarsi; coxae abruptly subconical, slightly shaded with brown, otherwise concolorous with body; trechanters subequal in length to coxae, reddish brown, slightly lighter in color than femora; femora, tibiae and tarsi dark reddish brown, unicolorous; femur and tibia of each leg subequal in length; femora moderately attenuate at both ends; tibiae subcylindrical; tarsal segments, two, subequal in length; ungues, broadly curved dark brown at base, pale brownish yellow distal.

Abdomen, conspicuously flexed dorsal; tergites, irregularly furrowed longitudinally; posterior abdominal segment produced caudal into a narrow conical projection. Odoriferous organs not distinctly visible.

Second Day

Length, 3.2 millimeters. In other respects answering to the same description as that for first day, with the following exceptions:

Thorax about one and one-third times as long as head; abdomen two and one-half times as long as head and thorax combined. Antennae, and fore and middle legs subequal in length to abdomen. Haustellum extending to caudal margin of first abdominal sternite. Abdomen narrowly subellipsoidal, due to ingestion of food; caudal portion acute; an odoriferous organ between third and fourth and fourth and fifth tergites.[1] Odoriferous organs linearly subelliptical; longer axis across abdomen; length slightly less than width of last visible abdominal segment, brown with diffused yellow border.

SECOND INSTAR

Length, 6 millimeters. General color yellowish green; lateral, yellowish brown line reported in first instar present; the line interrupted by a reddish brown dot between head and propleuron, between propleuron and mesopleuron and a somewhat indistinct one between mesopleuron and metapleuron; appendages dark reddish brown. Thorax two and one-half times as long as head; abdomen one and one-half times as long as head and thorax combined. Body and appendages sparsely and briefly pubescent.

Head elongate, over one and one-half times as long as broad, subequal in width from bases of antennal tubercle to caudal margin of head. Tylus and juga subequal in length; the former slightly deflexed, rounded spicad; two hairs visible subapical from dorsal aspect; juga porrect, subconical, subacute distal, very sparsely pubescent. Antennæ subequal in length to body, sparsely and briefly pubescent, more thickly but briefly so at Segment IV; I and III subequal in length; II three-fourths as long as either I or III; IV one and one-half times as long as III; diameter of I about one and one-fourth that of II; of II, III, and IV subequal; I subcylindrical, moderately and abruptly incrassate distal, uniformly dark brownish red; II subcylindrical, moderately and briefly attenuate proximal, opaque white, except a small portion distad and another one proximal, dark brownish red; III subcylindrical, uniformly dark brownish red; IV subcylindrical, slightly attenuate distad, subapical half and a small proximal portion reddish brown, the rest yellowish opaque white; apex terminating into a small black spot. Eyes hemispherical, brownish red, laterally set at about one-third cephalad between bases of antennal tubercles and caudal margin of head. Haustel-

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[1] Maxwell-Lefroy (7), working with *Leptocorisa varicornis* Fabs., finds these odoriferous glands "between second and third and third and fourth abdominal segments above." I do not believe that so wide a morphological difference could existe between that species and the very closely allied *L. acuta*. In all the nymphal instars of the latter species I worked with the divisions between the metathoracic and first abdominal segments and first and second abdominal segments were indistinct, and this characteristics, undoubtedly present also in the other insect, might have been responsible for the apparent error.

lum extending to about the middle of first abdominal sternite. Labrum slightly longer than Segment I of labium, slender, acutely pointed, greenish yellow basal, the rest brown. Labium pale brown, except I, which is concolorous with head basal and subbasal, and IV, which is piceous apical; suture visible as dark brown, thin median line; I, II, and IV subequal in length; III three-fourths as long as any of the other segments; I subcylindrical, conspicuously incrassate apical; II subcylindrical, moderately incrassate capital; III elongately subellipsoidal; IV subfusiform, acutely pointed at apex, very slightly attenuate proximal.

Thorax about three times longer than broad, moderately attenuate cephalad and confluent lateral with head; meso- and metathoraces subequal in length; prothorax three-fourths as long as mesothorax. Wing pads not evident. Fore and middle legs subequal in length, about three-fourths as long as body; hind leg about one and one-half times as long as either fore or middle; in all legs: coxæ subconical, subconcolorous with body; trochanters brownish red; femur of each leg subequal in length to adjoining tibia, brownish red, concolorous with trochanter, pro- and mesothoracic tibiæ opaque white basal portion brownish red and concolorous with femora and distal portion piceous; tarsal segments two, subequal in length to each other, piceous, concolorous with distal portion of tibiæ; ungues broadly curved; metathoracic tibia brownish red, concolorous with femur, a small distal portion piceous; metathoracic tarsal segments and ungues, as in other legs.

Abdomen subfusiform, four times longer than broad; caudal portion subacute and slightly produced. Odoriferous organs between third and fourth and fourth and fifth abdominal tergites; linearly subelliptical, brown, with diffused yellow border.

THIRD INSTAR

Length, 10 millimeters. General color yellowish green; lateral, yellowish brown line reported in the first and second instars present, dark olivaceous; the line interrupted by a reddish brown dot between head and propleuron, between propleuron and mesopleuron, and a somewhat indistinct one between mesopleuron and metapleuron; appendages dark reddish brown. General shape of body, narrowly subfusiform. Thorax one and one-half times as long as head; abdomen twice as long as head and thorax combined. Body and appendages very sparsely and briefly pubescent.

Head elongate, over one and one-half times as long as broad; subequal in width from base of antennal tubercles to caudal margin of head. Tylus three-fourths as long as juga, subconical, slightly deflexed, rounded apical, sparsely beset at apex with short hairs. Juga porrect, light yellow apical, concolorous with body basal, acutely subconical, apices inclined toward median line of body, very sparsely pubescent. Antennæ about three fourths as long as body, sparsely and briefly pubescent, more thickly and briefly so at Segment IV; I and III subequal in length; II three-fouths as long as either I or III; IV one and one-half times as long as III; diameter of I about one and one-fourth that of II; of II, and III, and IV subequal; I subcylindrical, moderately and abruptly incrassate distal, uniformly dark brownish red; II subcylindrical, moderately and briefly attenuate proximal, opaque white, except a small portion distal and another one proximal, dark brownish red; III subcylindrical, slightly attenuate distal, subapical half and a small proximal portion reddish brown, the rest yellowish opaque white; apex terminating into a small black spot. Eyes hemispherical, brownish red, laterally set at about one-third cephalad between bases of antennal tubercles and caudal margin of head. Haustellum extending to about the middle of bases of metathoracic coxæ. Labrum slightly longer than Segment I of labium, slender, acutely pointed, greenish yellow basal, the rest brown. Labium pale brown, except I, which is concolorous with head basal and subbasal, and IV, which is piceous apical; suture visible as dark brown, thin median line; I slightly longer than II; II one and one-fourth as long as III; III and IV subequal in length; I subcylindrical, conspicuously incrassate apical; II subcylindrical, moderately incrassate apical; III elongately subellipsoidal; IV subfusiform, acutely pointed at apex, very slightly attenuate proximal.

Thorax about three times longer than broad; moderately attenuate cephalad and confluent lateral with head; pro-, meso-, and metathoraces subequal in length. Pads of fore wings paler green than mesonotum, subtriangular; apex extending to cephalic fourth of metapleuron; costal margin subequal in length to mesopleuron. Pads of hind wings almost indistinct, concolorous with metanotum, subtriangular, costal margins one-third as long as those of fore wings. Fore and middle legs subequal in length; hind legs about three-fourths as long as either fore or middle; coxae subconical, subconcolorous with body; trochanter brownish red; femur of each leg subequal in length to its corresponding tibia, brownish red, concolorous with trochanter.

Pro- and mesothoracic tibiae opaque white, with proximal and subdistal portions brownish red; extreme distal portion piceous, concolorous with tarsi. Hind tibiae brownish red, faintly piceous at extreme distal portion. Tarsal segments, two; relatively subequal in length in all of the legs. Ungues broadly curved.

Abdomen narrowly subfusiform, four times longer than broad; caudal portion subacute and slightly produced caudal. Odoriferous glands two, between third and fourth and fourth and fifth abdominal tergites, length one-sixth the width of the tergites bounding them, narrowly crescentshaped with apieces pointing cephalad, yellowish brown, bounded by a yellow diffused area.

FOURTH INSTAR

Length, 12 millimeters. General color yellowish green; paler green ventral than dorsal; lateral line reported in previous instars previous instars present, dark olivaceous; line continued from metapleura through connexivum to abdominal caudal; a conspicuous, continuous greenish yellow median line on the abdominal sternites, in line with haustellum. Appendages reddish brown. General shape of body narrowly subfusiform. Thorax nearly twice as long as head; abdomen nearly twice as long as head and thorax combined. Body and appendages sparsely and briefly pubescent.

Head elongate, about two and one-half times as long as broad, subequal in width from bases of antennal tubercles to caudal margin of head. Tylus over one-half as long as juga, subconical, slightly deflexed, rounded apical. Juga porrect, light yellow apical, concolorous with body basal, acutely subconical, apices inclined toward median line of body, very sparsely and briefly pubescent. Antennæ about three-fourths as long as body, sparsely and briefly pubescent, more thickly but briefly so at Segment IV; I, III and IV subequal in length, II three-fourths as long as either of the other segments; I subcylindrical, abruptly incrassate distal, dark reddish brown, small basal portion green and concolorous with antennal tubercles; II subcylindrical, basal half reddish brown, diffusing distal into the opaque white, subdistal portion, a small apical part reddish brown; III subcylindrical, uniformly dark reddish brown; IV subcylindrical, attenuate apical, a small basal portion dark reddish brown, subbasal fourth yellowish opaque white; the rest of the segment yellowish brown, diffusing distal into a small brownish yellow apex. Eyes himespherical, red, set lateral near proximal third toward caudal margin of head. Haustellum about one third as long as body, apex extending to front of metathoracic coxæ. Labrum greenish yellow proximal and yellowish brown distal, slightly shorter than Segment I of labium. Labium dark yellowish brown except I, which is green and concolorous with body; I and II subequal in length; III and IV subequal in length; I or II nearly as long as III and IV combined; I subcylindrical, abruptly incrassate distal; II and III uniformly subcylindrical; IV from proximal to subapical region subcylindrical, apex acutely pointed.

Thorax about three times longer than broad, moderately attenuate cephalad, pro-, meso-, and metathoraces subequal in length. Pronotum subtrapezoidal, almost equilateral, cephalic margin being only slightly narrower than caudal. Scutellum triangular, subequal in length to pronotum. Fore-wing pads sublanceolate, about four times longer than broad, nearly twice as long as scutellum, extending caudal to about two-thirds of the metanotum, greenish yellow. Hind-wing pads almost completely hidden beneath fore-wing pads, sublanceolate, concolorous with body. Fore and middle legs subequal in length, about one-half as long as body; hind legs about one and one-third as long as either fore or middle; the three pairs conspicuously beset with moderately long hairs; coxæ subconical, subconcolorous with body; trochanter brownish red; femur of each leg subequal in length to its corresponding tibia, brownish red, concolorous with trochanter. Pro- and mesothoracic tibia whitish green with extreme distal portion piceous, concolorous with tarsi. Hind tibiæ brownish red, faintly piceous at extreme distal portion. Tarsal segments two, relatively subequal in length in all of the legs. Ungues broadly curved.

Abdomen narrowly subfusiform, about five times longer than broad; caudal portion subconoidal; sparsely and briefly pubescent. Odoriferous organs narrowly crescent-shaped with ends pointing cephalad; between third and fourth and fourth and fifth abdominal tergites; brown with diffused yellow border.

FIFTH INSTAR

Length, 16 millimeters. General color yellowish green, paler green at ventral than dorsal side; a greenish white line bordering lateral edges of pronotum and connexivum to the sixth abdominal segment. Lateral markings noted in previous instars distinct only on lateral sides of head and lateral margins of pronotum. Head one-half as long as thorax; abdomen about one and one-fourth as long as head and thorax combined. Body and appendages sparsely and briefly pubescent.

Head about two and and one-fourth times as long as broad. Tylus and juga porrect; the latter irregularly subconical, about twice as long as the former; the former acutely subconical. Antennæ about five-sixths as long as body; I four-fifths as long as IV, larger in diameter than any of the other segments; the other segments subequal in diameter; IV subequal in length to II and III combined; II slightly shorter than III; I irregularly subcylindrical, conspicuously and gradually incrassate distal, a small basal and a small apical portion red, the rest brownish olivaceous; II subuniformly cylindrical, pale whitish olivaceous, a small subbasal and apical portion dark brown, insertion into I red; III subcylindrical, moderately incrassate distal, pale whitish olivaceous, a small subbasal and a larger distal portion dark brown, insertion into II red; IV elongate subfusiform, basal fourth and apical eighth yellow, the rest dark brown. Antennal tubercles yellowish brown distal, concolorous with body basal. Two ocelli visible as reddish brown spots one-third from caudal margin of head to insertion of antennal tubercles. Eyes set near bases of antennal tubercles, subequal in diameter to distal ends of latter subhemispherical, reddish brown, concolorous with ocelli. Haustellum extending to and slightly beyond the middle of the mesothoracic coxæ. Labrum acutely subconical, brownish yellow, slightly shorter than Segment I of labium. Labial segments uniformly subcylindrical, except at distal portion of I, which is abruptly incrassate, and apical portion of IV, which is subconical; I subequal in length to II or to III and IV combined; III and IV subequal in length; I concolorous with body; II, III, and basal portion of IV brown, unicolorous; apex of IV dark brown almost black.

Length of thorax about twice its greatest breadth; metathorax subequal in width to abdomen and uniformly subequal in width cephalo-caudal; mesothorax, subequal in lenght to methathorax, and also in width at the caudal margin of the former, conspicuously attenuate thence to the cephalic margin; prothorax about three-fourths as long as either meso- or metathorax, moderately attenuate cephalad. Pronotum subtrapezoidal, subequal in length to scutellum, posterior margin bounded by a wavy line, about one and one-fourth the length of the anterior. Scutellum triangular, subequal in length to pronotum, pale yellowish olivaceous. Fore-wing pads sublanceolate, length about six times the breath, over twice as long as scutellum, extending to cephalic third of second abdominal tergite, pale yellowish olivaceous. Hind-wing pads about two-thirds as long as fore-wing pads, sublanceolate, subconcolorous with abdomen. Fore legs about two-thirds as long as abdomen; middle legs subequal in length to fore legs; hind legs a little longer than abdomen. In all legs: coxæ subconical, apple green concolorous with body; trochanters apple green; femora subequal in length to and about one and one-third larger in diameter than their corresponding tibiæ, basal halves apple green, distal halves olivaceous; tibiæ olivaceous, except a small distal portion at each tibia, which is brownish olivaceous; tarsi subequal in length; I brownish olivaceous, except at extreme distal portion, which is dark brown; II dark brown. Ungues dark brown, approaching black; broadly curved.

Abdomen four times longer than wide, broadly subellipsoidal; apple green; terminal caudal segment produced into a small cylindrical projection; abdominal caudal yellow. Odoriferous organs between third and fourth and fourth and fifth tergites; narrowly crescent-shaped with ends pointing cephalad; lateral borders dark brown; caudal margin greenish yellow.

DURATION OF ADULT STAGE

Numerous nymphs of the fifth instar were captured from the field and confined in battery jars. Young rice grains in the milk stage were used as food. From these materials it was possible to keep track of the emergence of the adults and secure living specimens of known ages. A record was kept of the date of emergence and date of death of a number of the individuals thus confined. Tables II and III give a record of the duration in the adult stage of nine males and nine females, respectively.

TABLE II.—*Duration of the adult stage—male*

Culture No.	Date emerged	Date died	Age at death
			Days
10	3-XII-18	19-II-19	78
14	6-XII-18	1-I-19	26
16	25-XII-18	1-IV-19	97
16 a	25-XII-18	11-III-19	76
13	25-XII-18	23-II-19	60
5	12-XII-18	7-II-19	57
30	25-XII-18	18-III-19	78
37	25-XII-18	25-II-19	62
104	24-II-19	22-III-19	26
Average			62
Maximum			97
Minimum			26

TABLE III.—*Duration of the adult stage—female*

Culture No.	Date emerged	Date died	Age at death
			Days
4	11-XII-18	27-II-19	78
8	2-XII-18	31-III-19	119
19	27-XII-18	13-III-19	76
14	6-XII-18	14-III-19	98
17	7-XII-18	10-IV-19	124
23	3-I-19	9-III-19	65
30	25-XII-18	10-III-19	75
37	25-XII-18	18-III-19	83
38	25-XII-18	18-III-19	83

Average	89
Maximum	124
Minimum	65

It appears from a comparison of the two preceding tables that, in the laboratory, the adult female lives longer than the adult male, the latter averaging sixty-two days from emergence till death, and the former eighty-nine days, or about 44 per cent longer than the male. Under laboratory conditions, the adult male was found to live from twenty-six to ninety-seven days from emergence, and the female from sixty-five to one hundred twenty-four days. Some variation from these figures might possibly obtain among adults at large, on account of their being under more natural field condition.

COPULATION

Duration.—Copulation is accomplished with the male and female in opposite directions to each other. No careful record has been made of the duration of each copulation; but casual observation in the laboratory seems to indicate that the process lasts for about six to ten hours.

Ages at first copulation.—The female was observed in the laboratory to require from seven to twenty-five days after emergence in order to reach sexual maturity, no case having been observed among the specimens in captivity where copulation took place before the female had completed the seventh day of the adult stage. No observation has been made on the age of male at sexual maturity. Table IV gives a record of copulation of eleven pairs of *Leptocorisae,* based on coupled confined in battery jars separately from the other specimens.

TABLE IV.—*Record of copulation*

Culture No.	Date of emergence	Date of first copulation	Date of second copulation	Date of third copulation	Age of at first copulation days	Interval between first and second copulation days	Interval between second and third copulation days
8	2-XII-18	24-XII-18	19-II-19	--------	22	57	--------
10	27-XII-18	8-I-19	4-II-19	7 III-19	12	27	31
11	4-XII-18	15 to 16-XII-18	--------	--------	11 to 12	--------	--------
14	6-XII-18	21-XII-18	20-I-19	--------	15	30	--------
23	3-I-19	28-I-19	19-II-19	5-III-19	25	22	14
25	7-XII-18	21-XII-18	(a)	--------	14	--------	--------
26	15-XII-18	22-XII-18	7-I-19	--------	7	16	--------
28	15-XII-18	26-XII-18	20-I-19	--------	11	25	--------
30	25-XII-18	8-I-19	1-II-19	25-II-19	14	24	24
37	25-XII-18	9-I-19	3-II-19	17-II-19	15	25	14
38	25-XII-18	9-I-19	--------	--------	15	--------	--------

[a] Discontinued.

Frequency of copulation.—In a majority of cases which were met with in the present experiments copulation was found to take place twice during the life of the female, the second taking place sixteen to fifty-seven days after the first (see Table IV). A few instances are also on record where a third copulation takes place fourteen to thirty-one days after the second (Table IV, column 8). No case has been met with where a fourth copulation takes place in the life of the female.

Time of copulation.—From both laboratory and field observations, it was noted that copulation, as a rule, takes place from early in the morning till about noon. Practically no *Leptocorisae* were found copulating after the noon hour. No observation was made to determine whether copulation takes place late after sunset.

OVIPOSITION

Place of oviposition.—Before laying eggs, the female flies about at shorter or longer distances from one leaf to another, until finally she settles down and remains quiescent for some time. She then places herself lengthwise with respect to the midrib of the leaf and with her head directed toward the leaf apex. The caudal portion of the abdomen comes in close contact with the leaf surface. After a few seconds in this position the eggs are laid, usually in succession in a row. As each egg is laid, the nether, concave portion becomes fastened to the leaf surface by the glue or a gluelike substance which covers the outer wall of the chorion. After an egg is laid, the female rests a few seconds before she lays the next one.

Time of oviposition.—Females confined in battery jars were observed to lay eggs most actively between 6 p. m. and 6 a. m. No oviposition was recorded as having taken place in the morning after 6 o'clock, and in a single instance in the case of a number of specimens captured from the field and crowded in a battery jar, eggs were observed to be laid between 3 and 4 p. m.

Age of female at first oviposition.—The first batch of eggs is laid usually on the day of copulation or that immediately following. Table V gives the results obatined from seven female specimens experimented with in the laboratory. It can be seen from this table that the female lays her first batch of eggs eleven to forty-four after emergence, the average being twenty-four days.

TABLE V.—*Age of female at first oviposition and duration of the egg-laying period*

Culture No.	Date of emergence	Date of first oviposition	Date of last oviposition	Age at first oviposition	Age of last oviposition	Egg-laying period
				Days	*Days*	*Days*
8	2-XII-18	4-I-19	26-III-19	33	114	81
10	29-XII-18	9-I-19	11-III-19	11	73	62
14	6-XII-18	22-XII-19	14-III-19	16	98	82
17	7-XII-18	20-I-19	9-IV-19	44	123	79
23	3-I-19	29-I-19	8-III-19	26	64	38
30	25-XII-18	13-I-19	7-III-19	19	72	53
38	25-XII-18	12-I-19	11-III-19	18	76	58
Average				24	89	65

Duration of the egg-laying period.—It is doubtful if the maximum number found in laboratory observations fairly represents the greatest number of days at which the female lays her eggs, as it was found on examination of dead females which were dissected at the end of each of the present experiments that eggs, ranging from 2 to 12 in number, were present in the oviducts. This would appear to indicate that the female had not yet reached the end of her laying period when she died. But the figures obtained should at least represent the length of time at which the female could be expected to lay eggs. Table V, column 7, gives thirty-eight to eighty-two days as the range of the egg-laying period, the average being sixty-five days. The same table, column 6, also gives sixty-four to one hundred twenty-three days and an average of eighty-nine days as the ages of the female at the time of cessation of egg-laying.

Number of days from cessation of oviposition to death of female.—The female lives for some time after the end of the egg-laying period. From an examination of Table VI and Charts 1 to 11, it will be noted that the female does not lay eggs regularly during successive days. Egg-laying is frequently interrupted by a number of consecutive days when no eggs are laid, at the end of which time oviposition is resumed, only to drop again suddenly to zero. Table VI and Charts 1 to 11 give the daily rate of oviposition of eleven females during the egg-laying period.

TABLE VI.—*Daily record of eggs laid*

Days of oviposition	Culture										
	8	10	11	14	17	18	26	27	30	37	38
	Eggs laid by female daily										
1st	2	8	13	5	1	12	6	15	8	12	10
2nd	4	4	0	0	5	0	0	0	8	0	0
3rd	0	4	7	2	0	4	0	0	8	9	1
4th	1	5	0	6	0	7	10	0	2	0	11
5th	0	0	0	2	6	0	5	0	0	12	0
6th	0	10	15	0	0	5	11	16	0	0	0
7th	1	0	9	0	2	16	0	0	17	9	0
8th	1	14	0	6	0	0	13	0	0	0	13
9th	0	3	0	7	0	13	9	0	5	17	4
10th	0	0	11	2	2	0	6	0	0	0	0
11th	2	8	0	9	0	12	0	0	6	1	7
12th	1	8	15	5	0	0	7	0	0	7	0
13th	6	2	9	6	0	11	2	4	12	4	4
14th	5	0	3	6	0	0	c 12	0	0	5	4
15th	0	10	23	0	16	11	0	0	0	0	5
16th	0	4	0	5	0	0	12	0	5	7	0
17th	0	5	d	9	0	3	0	6	6	0	14
18th	0	0	------	5	0	0	7	0	0	0	0
19th	0	13	------	5	7	7	1	0	c 8	3	0
20th	0	0	------	4	0	9	12	0	0	13	1
21st	7	9	------	0	0	8	0	3	7	0	0
22nd	0	8	------	0	2	7	4	0	9	9	11
23rd	0	0	------	11	0	12	13	0	0	0	0
24th	0	12	------	3	0	c 2	3	0	9	c 0	2
25th	0	5	------	0	0	10	6	0	0	15	2
26th	0	8	------	0	14	1	7	0	0	0	3
27th	0	0c	------	1	0	c 10	0	0	14	0	0
28th	7	0	------	3	0	3	8	0	5	0	5
29th	0	9	------	0	4	8	0	0	0	0	8
30th	0	0	------	c 9	0	5	0	0	11	0	3
31st	0	10	------	0	0	14	16	0	0	11	4
32nd	0	8	------	0	0	0	0	0	4	0	3
33rd	4	6	------	0	10	14	6	0	0	12	2
34th	0	0	------	7	0	7	11	0	13	0	15
35th	0	14	------	5	0	d	0	0	3	0	1
36th	0	0	------	6	10	------	8	0	6	0	5
37th	0	0	------	0	8	------	0	0	8	c 17	0
38th	0	9	------	1	0	------	0	0	0	0	4
39th	0	10	------	10	1	------	6	0	10	6	0
40th	0	6	------	0	7	------	9	0	7	12	9
41st	0	0	------	0	0	------	0	0	7	0	3
42nd	0	17	------	6	12	------	0	0	5	11	4
43rd	0	0	------	0	c 9	------	3	9	5	0	8
44th	0	0	------	3	0	------	0	0	2	19	3
45th	0	20	------	12	7	------	0	1	0	0	0
46th	c 0	8	------	0	7	------	0	0	2	0	6
47th	0	0	------	4	5	------	13	20	2	12	2
48th	0	13	------	0	7	------	0	0	2	0	4
49th	0	0	------	0	0	------	0	0	0	6	3
50th	0	15	------	10	7	------	0	13	0	7	0
51st	0	8	------	5	6	------	0	0	2	7	4
52nd	6	0	------	0	0	------	d	0	9	0	4
53rd	0	0	------	16	0	------	------	3	0	0	7
54th	8	9	------	0	2	------	------	15	14	19	0
55th	4	9	------	0	6	------	------	0	0	0	0
56th	0	0	------	0	0	------	------	0	0	0	0
57th	13	0	------	0	3	------	------	0	c 0	0	9

Explanation of sign: c = in copula; d = died.

Average total number of eggs: 212

TABLE VI.—*Daily record of eggs laid*—Continued.

Days of oviposition	Culture										
	8	10	11	14	17	18	26	27	30	37	38
	Eggs laid by female daily										
58th	0	c 0	------	2	2	------	------	0	------	9	4
59th	7	11	------	15	7	------	------	0	------	4	0
60th	4	3	------	0	1	------	------	12	------	1	0
61st	0	1	------	3	12	------	------	9 c	------	0	0
62nd	10	6	------	0	0	------	------	0	------	11	0
63rd	0	0	------	17	0	------	------	0	------	0	0
64th	0	d	------	0	11	------	------	0	------	0	0
65th	4	------	------	11	0	------	------	13	------	d	d
66th	8	------	------	1	7	------	------	0	------	------	------
67th	0	------	------	0	0	------	------	0	------	------	------
68th	4	------	------	2	2	------	------	0	------	------	------
69th	0	------	------	0	0	------	------	0	------	------	------
70th	7	------	------	0	0	------	------	2	------	------	------
71st	0	------	------	7	0	------	------	2	------	------	------
72nd	9	------	------	0	1	------	------	7	------	------	------
73rd	0	------	------	0	0	------	------	0	------	------	------
74th	2	------	------	7	4	------	------	0	------	------	------
75th	2	------	------	0	0	------	------	0	------	------	------
76th	6	------	------	11	0	------	------	8	------	------	------
77th	0	------	------	1	0	------	------	0	------	------	------
78th	7	------	------	5	0	------	------	0	------	------	------
79th	8	------	------	6	0	------	------	0	------	------	------
80th	5	------	------	1	4	------	------	0	------	------	------
81st	d 4	------	------	8	d	------	------	0	------	------	------
82nd	------	------	------	0	------	------	------	0	------	------	------
83rd	------	------	------	d 1	------	------	------	0	------	------	------
84th	------	------	------	------	------	------	------	0	------	------	------
85th	------	------	------	------	------	------	------	0	------	------	------
86th	------	------	------	------	------	------	------	0	------	------	------
87th	------	------	------	------	------	------	------	d	------	------	------
Total number of eggs laid	158	334	105	294	204	228	213	158	141	286	212

Explanation of sign: c = in copula; d = died.
Average total number of eggs: 212

The following facts may be noted from a study of the above tables and charts:

1. During the egg-laying period, the number of eggs laid per day ranges from 0 to 23.
2. Whenever a female lays a large number of eggs, a sudden drop to a much smaller number or to zero invariably follows on the day following. This temporary cessation of egg-laying may be explained as an effort of the insect to rest and recover from the exhaustion attendant to every rapid oviposition.
3. The drops to zero occur suddenly and frequently, during the course of the egg-laying period.
4. The females that have the highest daily rates of oviposition appear to have a shorter egg-laying period than the ones that have a comparatively lower rates of oviposition.

Total number of eggs laid by one female.—Table VI gives 105 to 334 as the range of total number of eggs that a female *Leptocorisa* was found to produce from the beginning of oviposition till the last batch of eggs was laid. The average is given in the same table as 212. As noted the insect is possibly capable of laying many more eggs than the maximum found in the present experiments, in view of the fact that postmortem dissection of the specimens used invariably resulted in the finding of fully developed eggs in the oviducts.

The egg batch.—From the habit of the insect of sitting on a leaf and continuously laying eggs until she has finished laying all the day's quota, we have reason to believe that each batch of eggs found in the field represents, as a rule, the result of the day's oviposition of a female *Leptocorisa.* Table VII, Column 2, gives the number of eggs in forty-one egg hatches found in the field. According to this table, the eggs in each batch range from 1 to 20, the average being 6. These figures confirm by a close margin the results of the laboratory experiments on the rate of oviposition per day, of which, as reported in Table VI, the maximum is 23.

TABLE VII.—*Description of egg batches from the field*

Batch number	Number of eggs in batch	Number of rows	Characteristics of rows
I	13	1	Regular, straight.
II	8	2	Irregular; only 4 eggs in straight row.
III	2	1	Regular.
IV	19	1	Regular; 3 eggs off the line.
V	8	2	Subregular; 1 egg off the line.
VI	5	1	Subregular.
VII	7	1	do.
VIII	7	1	Regular.
IX	7	2	Subregular.
X	13	2	Irregular.
XI	17	1	do.
XII	16	1	Subregular.
XIII	2	1	Regular.
XIV	10	2	Subregular; second row with 1 egg only.
XV	8	1	Subregular; 6 eggs in straight lines.
XVI	1		
XVII	12		Irregular.
XVIII	3	1	Subregular.
XIX	6	2	Subregular; rows 2 and 4 eggs, respectively.
XX	3	2	Subregular.
XXI	9	2	First row straight line; second row one egg only.
XXII	13	1	Subregular.
XXIII	9	1	Irregular.
XXIV	7	1	Regular, straight.
XXV	7	1	Subregular.
XXVI	4	1	Regular, straight.
XXVII	9	1	Regular, straight.
XXVIII	7	1	Subregular.
XXIX	10		Irregular.
XXX	9	2	Subregular; rows 3:6.
XXXI	7	2	Subregular; rows 2:5.
XXXII	1		
XXXIII	4	1	Regular, straight.
XXXIV	11	1	do.
XXXV	10	1	Subregular.
XXXVI	9	1	do.
XXXVII	6	1	Regular, straight.
XXXXIII	6	1	Subregular.
XXXIX	8	2	Subregular; rows 3:5.
XL	10	2	Subregular; rows 1:9.
XLI	20	2	Regular; rows 2:10.
Average	6		

It will further be noted from a study of Table VII that a majority of the egg batches were arranged in one row, and a lesser number in double rows. Na case of rows over two has been met with. The eggs in the row were regularly or irregularly set in a straight line, only a few instances having been found where the arrangement may be classed as irregular. In every batch examined the end of the eggs marked by the white wax-covered spot were found to incline uniformly in one direction, usually toward the leaf apex.

Position of eggs on leaves.—In a large majority of cases, the egg batches are located on the upper leaf surface, which fact can readily be noted on casual examination of a rice field infested by *Leptocorisa.* They are also most commonly found on or a short distance from and always with the rows running parallel to the leaf midrib. Table VIII summarizes the results obtained from an examination of twenty-one leaves with egg batches, which were collected from the field.

TABLE VIII.—*Positions of eggs on leaves*

Leaf number	Leaf surface where found	Distance from apex	Direction from midrib	Distance from midrib	Date found
		mm.		*mm.*	
I	upper	147.5	midrib	----------	18-XI-18
II	upper	62.5	left	0	18-XI-18
III	upper	230.0	left	3	18-XI-18
IV	upper	87.5	midrib	0	18-XI-18
V	upper	179.5	right	3.5	18-XI-18
VI	upper	346.5	left	0	18-XI-18
VII	upper	106.5	midrib	----------	18-XI-18
VIII	upper	218.5	midrib	----------	18-XI-18
IX	nether	50.5	midrib	----------	18-XI-18
X	upper	198.0	left	0	20-XI-18
XI	upper	280.0	right	0.5	20-XI-18
XII	upper	196.0	left	0	20-XI-18
XIII	upper	207.0	right	1.5	20-XI-18
XIV	upper	35.0	left	0	20-XI-18
XV	upper	24.0	midrib	0	20-XI-18
XVI	upper	206.5	left	0	20-X1-18
XVII	upper	251.0	midrib	0	20-XI-18
XVIII	upper	7.0	midrib	0	20-XI-18
XIX	upper	262.0	left	1.5	20-XI-18
XX	nether	419.5	right	2.0	20-XI-18
XXI	upper	189.0	left	1.5	20-XI-18

The above table shows that of the 21 leaves, 19, or 90.5 per cent had the egg batches on the upper surface, only 2 having been found to have them located on the nether. Eight of the egg batches were located on the midrib, 9 to the left of the midrib and 4 to the right. Column 5 shows that 14 were found to be either on or immediately adjoining the midrib, while the other 7 were only separated from the midrib by a distance of from 0.5 to 3.5 millimeters. The distance of the batch from the apex of the leaf, as shown by column 3, ranged from 7 to 419.5 millimeters, the average being 176.4 millimeters. From the foregoing observations, the following general statements may be made with regard to the position of the egg batches on the leaves: (1) The batches are located longitudinally with respect to the midrib of the leaf; (2) the white wax-covered spot generally points toward the leaf apex; (3) the majority of the batches are present on the upper surface, cases being only occasionally found where they are found on the nether surface; (4) the batches are placed generally on or a short distance from the midrib; and (5) the distance from the leaf apex is, on the average, nearly two decimeters.

Period of egg incubation.—A large number of adult individuals were captured from the field and the interior wall of the jar and on the food plant, introduced into the jar. As many of the eggs as could be removed with a portion of the object to which they were attached were transferred to the Petri dishes and labeled properly. Only four of these batches hatched, and the results are recorded in Table IX.

TABLE NO. IX.—*Egg incubation*

Culture No.	Date of egg laying	Date of hatching	Length of incubation period
			Days.
3	22-XI-1918	30-XI-1918	8
9	26-XI-1918	2-XII-1918	6
15	29-XI-1918	6-XII-1918	3
16	29-XI-1918	7-XII-1918	8

Average	7.25
Maximum	8
Minimum	6

The above table gives the minimum incubation period in the laboratory as six days, the maximum 8 and the average 7.25. The maximum and minimum ranges coincide with the results of Maxwell-Lefroy's (7) observation on *Leptocorisa varicornis*, in India.

OBSERVATIONS ON THE NYMPHS

General.—After hatching from the egg, the nymph soon becomes strong enough to walk about rather actively. Feeding begins three or four hours after hatching. The nymphs in all instars appear to stay most of the time on the rice panicles which serve as their food plants.

Duration of instars.—The nymph passes through five instars, at the end of which the adult insect emerges. Table X gives a record of the duration of instars of eighteen nymphs and the total number of days in the nymphal stage.

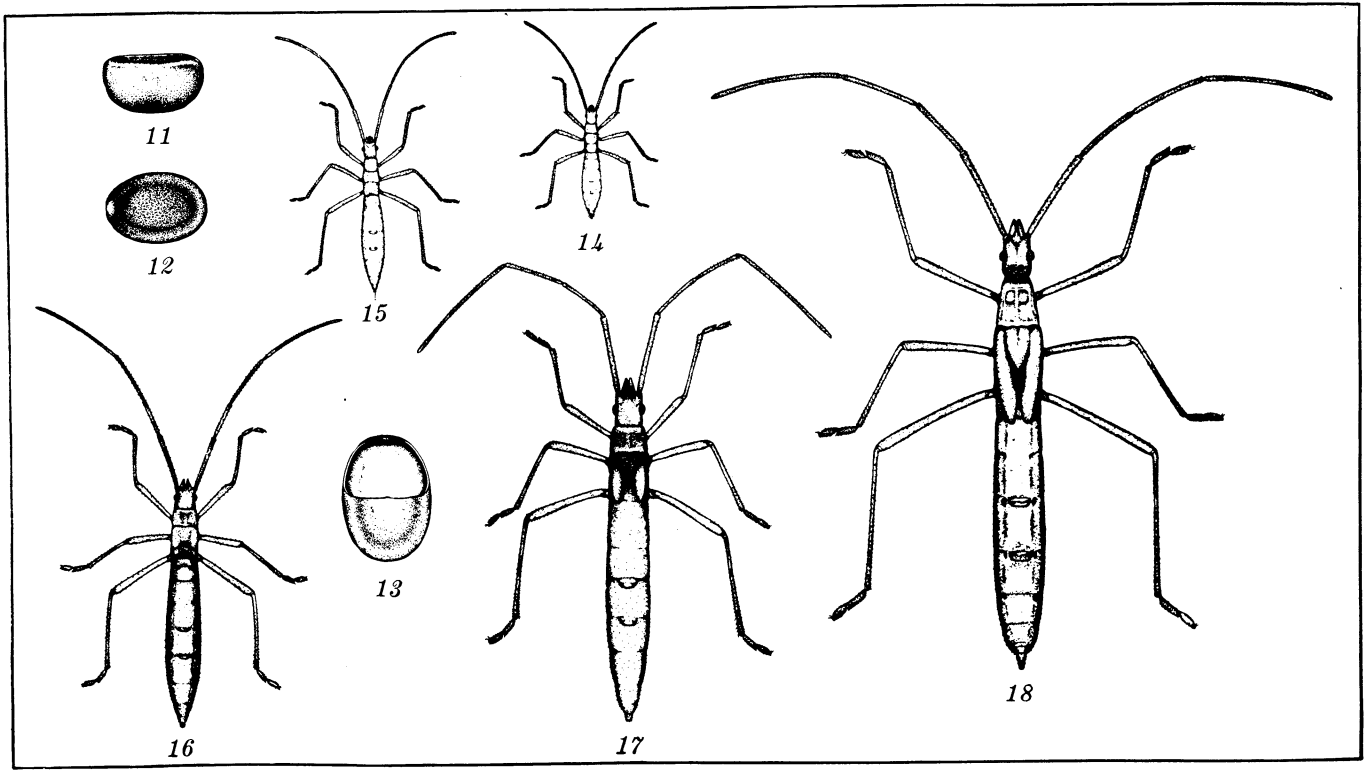
TABLE X.—*Duration of instars and total number of days in the nymphal stage*

Culture No.	4		5		6	
	Date	Number of days between ecdyses	Date	Number of days between ecdyses	Date	Number of days between ecdyses
Eggs hatched	23-XI-18	--------	24-XI-18	--------	23-XI-18	--------
First molt	25-XI-18	2	26-XI-18	2	25-XI-18	2
Second molt	29-XI-18	4	29-XI-18	3	29-XI-18	4
Third molt	1-XII-18	2	1-XII-18	2	2-XII-18	3
Fourth molt	4-XII-18	3	4-XII-18	3	6-XII-18	4
Fifth molt	11-XII-18	7	12-XII-18	8	12-XII-18	6
Length of nymphal stage	-----------	18	-----------	18	-----------	19

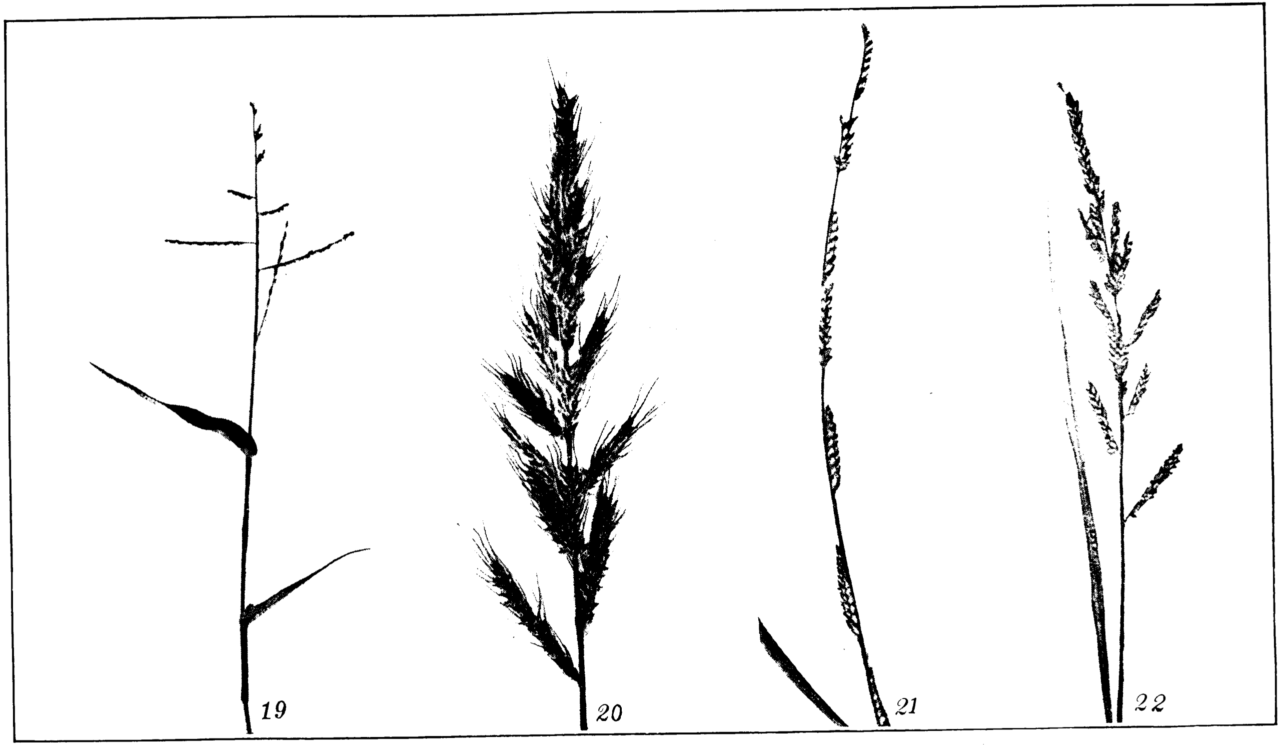
Culture No.	13		16		19	
	Date	Number of days between ecdyses	Date	Number of days between ecdyses	Date	Number of days between ecdyses
Eggs hatched	6-XII-18	--------	7-XII-18	--------	8-XII-18	--------
First molt	10-XII-18	4	11-XII-18	4	15-XII-18	4
Second molt	12-XII-18	2	14-XII-18	3	14-XII-18	2
Third molt	15-XII-18	3	16-XII-18	2	17-XII-18	3
Fourth molt	19-XII-18	4	21-XII-18	5	21-XII-18	4
Fifth molt	25-XII-18	6	25-XII-18	4	25-XII-18	4
Length of nymphal stage	-----------	19	-----------	18	-----------	17

Culture No.	20		27		108	
	Date	Number of days between ecdyses	Date	Number of days between ecdyses	Date	Number of days between ecdyses
Eggs hatched	9-XII-18	--------	23-XII-18	--------	1-II-19	--------
First molt	13-XII-18	4	27-XII-18	4	7-II-19	6
Second molt	18-XII-18	5	30-XII-18	3	11-II-19	4
Third molt	20-XII-18	2	3-I-19	4	14-II-19	3
Fourth molt	23-XII-18	3	6-I-19	3	18-II-19	4
Fifth molt	28-XII-18	5	13-I-19	7	24-II-19	6
Length of nymphal stage	-----------	19	-----------	21	-----------	23

Culture No.	109		110		111	
	Date	Number of days between ecdyses	Date	Number of days between ecdyses	Date	Number of days between ecdyses
Eggs hatched	4-II-19	--------	1-II-19	--------	6-II-19	--------
First molt	9-II-19	5	5-II-19	4	10-II-19	4
Second molt	12-II-19	3	8-II-19	3	13-II-19	3
Third molt	15-II-19	3	12-II-19	4	17-II-19	4
Fourth molt	18-II-19	3	15-II-19	3	21-II-19	4
Fifth molt	24-II-19	6	21-II-19	6	26-II-19	5
Length of nymphal stage	-----------	20	-----------	20	-----------	20



11. Egg, side view; 12. Egg, upper view; 13. Chorion, upper view, showing opening made by nymph on hatching; 14. Nymph, first instar; 15. Nymph, second instar; 16. Nymph, third instar; 17. Nymph, fourth instar; 18. Nymph, fifth instar.



Wild host plants of Leotocousa acuta Thunberg

19. *Panicum reptans* Linn.; 20. *Panicum cruss-galli* Linn.; 21. *Panicum flavidum* Retz.; 22. *Panicum colonum* Linn.

TABLE X.—*Duration of instars and total number of days in the nymphal stage*—Continued.

Culture No.	112		114		115	
	Date	Number of days between ecdyses	Date	Number of days between ecdyses	Date	Number of days between ecdyses
Eggs hatched	31-I-19	--------	1-II-19	--------	31-I-19	--------
First molt	4-II-19	4	5-II-19	4	4-II-19	4
Second molt	7-II-19	3	8-II-19	3	8-II-19	4
Third molt	10-II-19	3	11-II-19	3	12-II-19	4
Fourth molt	15-II-19	5	14-II-19	3	16-II-19	4
Fifth molt	22-II-19	7	20-II-19	6	22-II-19	6
Length of nymphal stage	------------	22	------------	19	------------	22

Culture No.	116		117		118	
	Date	Number of days between ecdyses	Date	Number of days between ecdyses	Date	Number of days between ecdyses
Eggs hatched	6-II-19	--------	6-II-19	--------	16-II-19	--------
First molt	10-II-19	4	10-II-19	4	20-II-19	4
Second molt	14-II-19	4	12-II-19	2	23-II-19	3
Third molt	18-II-19	4	16-II-19	4	26-II-19	3
Fourth molt	22-II-19	4	19-II-19	3	2-III-19	4
Fifth molt	27-II-19	5	25-II-19	6	7-III-19	5
Length of nymphal stage	------------	21	------------	19	------------	19

Culture No.	Minimum	Maximum	Average	
Eggs hatched	----------	----------	----------	----------
First molt	2	6	3.8	First instar.
Second molt	2	5	3.2	Second instar.
Third molt	2	4	3.2	Third instar.
Fourth molt	3	5	3.8	Fourth instar.
Fifth molt	5	8	5.8	Fifth instar.
Length of nymphal stage	----------	----------	19.6	

The above table shows that the first instar lasts from two to six days; the second, two to five days; the third, two to four days; the fourth, three to five days; and the fifth, five to eight days. The entire nymphal stage occupies a period of seventeen to twenty-three days, averaging 19.6 days. From the column of averages of the different instars in Table X and from Chart 12, it will be seen that the average duration in days of the first, second, third, and fourth instars is practically the same for the four, viz., 3.8, 3.2, 3.2, and 3.8 days, respectively, while in the fifth instar, the time occupied becomes comparatively very much longer, 5.8 days. This great increase may be accounted for by the fact that the insect in the fifth instar requires a longer time to prepare itself for its transition to the adult stage.

Comparison of nymphal instars and adults.—Table XI gives a comparative descriptive summary of *Leptocorisa* in its different instars, the points considered in each case being total length of body, presence or absence of wing pads, length of haustellum with respect to body, number of ocelli, comparative length of tylus and juga, and of antennae and body, position of odoriferous glands and number of tarsal segments. Chart 13 shows graphically the comparative lengths of the different instars and the adult.

TABLE XI.—*Comparison of nymphal instars and adult*

Stage	Length	Wing pads	Haustellum	Ocelli	Tylus juga ratio	Antennae body ratio	Odoriferous glands	Tarsi
	mm.							
Nymph, first day first instar, second day.	1.5 3.2	absent	Nearly as long as body.	absent	1:1	3:1	abdominal	2
Nymph, second instar.	6	absent	To first abdominal sternite.	absent	1:1	1:1	abdominal	2
Nymph, third instar.	10	present	To middle of metathoracic coxae.	absent	3:4	3:4	abdominal	2
Nymph, fourth instar.	12	present	To front metathoracic coxae.	absent	1:2	3:4	abdominal	2
Nymph, fifth instar.	16	present	To middle of mesothoracic coxae.	two	1:2	5:6	abdominal	2
Adult	16	wings	To middle of mesothoracic coxae.	two	1:2	1:1	thoracic	3

NOTE:—Instar *la* represents first instar, first day; and *lb*, first instar, second day.

The nymph of the first instar measures 1.5 millimeters in length during the first day and almost doubles to 3.2 millimeters in the second day due to ingestion of food; the second instar, 6 millimeters, or almost double that of the second day of the first instar; the third instar, 10 millimeters; the fourth instar, 12 millimeters, which represents but a slight increase; and the fifth instar, 16 millimeters. The adult has practically the same length as the fifth nymphal instar.

From examination of external characters, the wing pads are absent in the first and second instars and do not begin to become visible until the third instar.

The haustellum is as long as the body in the first instar and gradually becomes proportionately shorter with each successive molt. The adult and the fifth nymphal instar have the same length of haustellum in proportion to the body.

Two ocelli begin to appear only in the fifth nymphal instar, these being entirely wanting in any of the previous instars.

The tylus is slightly longer than the juga in the first instar; becomes equal in length in the second and is three-fourths shorter in the third; in the fourth and fifth instars and in the adult stage the tylus is one-half the length of the juga.

The antennae are three times as long as the body in the first instar, equal in length in the second, three-fourths as long in the third and fourth, five-sixths as long in the fifth, and equally as long as the body in the adult stage.

The odoriferous glands are abdominal in all the nymphal instars and is thoracic in the adult only.

There are two tarsal segments present in all the instars in the nymphal stage and three in the adult.

NATURAL ENEMIES

Maxwell-Lefroy (7, 8) and Stebbing (11) report the presence in India of a tiger bettle, *Cicindela sexpunctata* Fabr., which "flies actively and destroys the bugs in numbers," and the former author also mentions an egg parasite. Koningsberger (4) also reports an egg parasite in Java.

Cicindela sexpunctata has not been met with the present experiments, although Schultze (?) gives it in his list of Coleoptera from the Philippines. An egg parasite, however, was found to be present in as many as 25 per cent of the eggs brought into the laboratory from the field during certain seasons of the year. Specimens bearing College of Agriculture accession No. 18424 and dated November 30, 1918, turned out to be Proctotrypioids.

DISCUSSION OF CONTROL METHODS AND RECOMMENDATIONS

Indian methods.—In India, where *L. varicornis* has been studied to some extent (7, 8), the principal method recommended for the control of the pest, consists in mechanically capturing the rice bugs with elongated bags drawn rapidly across the field. The interior of the bag is previously coated with some sticky material, like crude-oil emulsion. This method which is said to be a modification of the south Indian method, has been adapted for use in India by Maxwell-Lefroy (7) after "a careful study of this pest and practical repeated attempts to rid the rice cultivation on the Pusa Farm of it." Other methods mentioned by this author as being in use to some extent in certain parts of India and which is said to have been more or less successful are: 1. Burning certain aromatic herbs and resinous substances in such a position that the smoke may be carried by the wind over the field. 2. Dragging ropes saturated with resin or kerosene

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(?) Schultze, W. A Catalogue of Philippine Coleoptera: 12. Manila, 1915.

oil across the field. 3. Catching the bugs on the rice panicles into a paddy winnow that has been previously rubbed inside with the latex of the bread-fruit (*Artocarpus communis* Forst.). 4. Baiting the insects with a mixture of bran and *gur* (molasses?).

Control practice in the Philippines.—In the Philippines no adequate method has as yet been employed for the control of this pest. The farmers in the vicinity of Bay, Laguna, occasionally use *incenso* and *camañgian,* which are kinds of resin, or lumbang nuts (*Aleurites moluccana* (L.) Wild.) for smoking in the field. It is believed in that locality that the treatment results in driving the bugs away from the fields, but this supposed effect is probably more imaginary than actual. Another substance which the farmers believe to be a repellant is finely mashed *digman* (*Hydrilla verticillata* (Roxb.) Royle), placed in small cloth bags and hung on different places in the field. It was reported by the Bureau of Agriculture that pieces of decaying meat hung up on poles attract the adult rice bugs by their putrid odor, and it was also suggested that this form of bait be used. Mackie (6) advocated the "delaying of planting of quick-maturing varieties in order that the entire crop will ripen at the same time, thereby preventing the pest from concentrating its damage on one variety."

Recommendations.—Extensive experiments on control measures in the field should be conducted, and it is only on the results obtained from these sources that definite method of effectively combating this insect pest may be adequately based. The present biological observations on the rice bug, both in the laboratory and in the field, do not include the actual field tests of control measures, as it is planned to have the latter subject the basis of another series of experiments which will have to be carried through several years. From the results of the present work, the following points suggest themselves in connection with control measures for *Leptocorisa acuta,* each one of which would require more extensive study and confirmation before being finally recommended for general practice in the Philippines:

1. *Natural enemies.*—The multiplication of the Proctotrypoid egg-parasite should be encouraged. Steps should be taken to secure importations of living specimens for propagation in this country of other egg-parasites and predaceous insects, which may not be present here yet, from India and other old rice-producing countries. Where other methods had proved a failure, the introduction of parasitic and predaceous insects was found to be the only effective means of controlling certain insect pests in Hawaii and in the United States.

2. *Regulating the rainy-season planting.*—It appears that trouble from this pest is not very serious with the dry-season rice, i. e., rice that heads near the months of March and April. November and December are the months when *Leptocorisa acuta* is found most abundant in Los Baños and the neighboring towns, and a small rice area which may reach the milk stage earlier than the adjoining rice fields will be sure to attract the rice bugs in the vicinity and be destroyed by the pests. Planting should, therefore, be so regulated as to have the rainy-season rice attain the milk stage at about the same time in a given locality. Where irrigation water is abundant, it may be advisable to defer the planting so as to have the grains come to the milk stage at about the end of January or during February.

3. *Production of immune or less susceptible strains by breeding and selection.*—See discussion under the heading "Susceptibility of Different Rice Varieties," on page 93.

4. *Traping.*—An early planting of rice on a small area serving as the main attraction for the rice bug suggests that several such plantings can be made at different places on a given area as a trap. After the adults collect in number on these small patches and lay eggs for some time, fire may be set to the plants, thus burning the adults, the eggs and all the nymphs that may have hatched. In this way the attacks on subsequent larger plantings may be greatly diminished. The adults may also be trapped by pieces of decaying meat or other suitable baits and destroyed. Since the adults are more abundant in the field at any time than the younger stages, and since they are the ones that most readily get access to baits, the prospect of controlling the pest by trapping appears to be promising.

5. *Catching the adults by an elongated bag dragged across the field, as practiced in India.*

6. *Clean culture of the fields during and after the rice season.*—During the rice season, wild grasses, which usually mature earlier than rice and a number of which have been found to be food plants of *Leptocorisa* should be kept weeded out so as not to serve as places of anchorage for the season's attack by the pest. The dikes should, likewise, be kept free from weeds. After harvest time, the ground should be plowed and planted with another crop, and not allowed to run to weeds, as the usual practice in many places in the Philippines.

7. *Handpicking of eggs.*—Where cheap labor is available, farm helpers may be trained to locate the eggs. As the eggs occur in clusters usually on the upper surface of the leaf, at a short distance from the apex, there ought to be no difficulty in

collecting and destroying them. This practice will help very greatly to diminish the pest.

8. *Spraying.*—Contact insecticides, like kerosene emulsion, sprayed with a knapsack pump, which can be carried along the field on the back of the operator, may prove to be a satisfactory method of control, especially for the nymphs usually cluster on the panicles during the cooler parts of the day, spraying should be done early in the morning or late in the afternoon and the spray needs to be directed only on the panicles. The rice plant is susceptible to the attack of the rice bug when it is in the milk stage, and, since this stage is only of about one month's duration, the treatment needs to be applied only for this length of time. Application of sprays should be made rather frequently during this one month so as to catch the rice bugs that may have fallen to the ground or otherwise escaped in the previous treatment.

SUMMARY

1. *Leptocorisa acuta* Thunberg belongs to the family Coreidae, subfamily Alydinae, tribe Leptocorisaria, suborder Heteroptera, order Rhynchota or Hemiptera.

2. The insect is known in different parts of the Philippines under a number of dialect names which have a certain degree of resemblance to each other.

3. *L. acuta* has also been reported from India, China, Java, Celebes, Sumatra, Sunda Isles, Borneo, and Australia.

4. Practically no biological work has been done on the rice bug in the Philippines.

5. The rice bug is probably equalled by no other insect in the Philippines in its ability to cause damage on rice.

6. The adults have been noticed to be more abundant than the nymphs in the field at all seasons.

7. The rice bugs at Los Baños and vicinity begin to be present in fairly large numbers in August and are most abundant during November and December. Since the rainy-season rice mostly reaches the milk stage during those two last months, it naturally suffers more than the dry-season planting.

8. The rice bug is injurious on the rice in all stages after hatching from the egg.

9. The attack of the insect results in emptiness of the grains and the symptoms are likely to be confused with the work of the rice borer (*Schoenobius incertellus* Wlk.), which produces a similar general effect.

10. The early planting of rice on a small scale, where it will attain the milk stage earlier than the other plantings in the

surrounding area, results in attracting to the former the rice bugs present in the neighborhood.

11. Rice can be injured by the rice bug only when the former is in the milk stage.

12. Certain varieties of rice, especially the bearded ones, appear to be less susceptible to the attacks of the rice bugs than others.

13. The insect has a number of wild grasses on which it lives and breeds when rice is not growing.

14. Under laboratory conditions, the life of the male after emergence was found to last for from twenty-six to ninety-seven days, with an average of 62 days; of the female, sixty-five to one hundred twenty-four days, with an average of eighty-nine days.

15. The female does not reach sexual maturity until seven to twenty-five days after emergence.

16. Copulation takes place three times at most during the life of the female, this process occurring toward and during the morning hours.

17. The hours of most active oviposition are, between 6 p. m. and 6 a. m.

18. The female lays eggs eleven to forty-four days after emergence, the average being twenty-four days.

19. The egg-laying period of the insect was found in the laboratory to range from thirty-eight to eighty-two days, the average being sixty-five days.

20. The female lives as much as eleven days longer after the egg-laying period has ceased.

21. The rate of egg-laying per female per day ranges from 0 to 23.

22. The total number of eggs laid during the egg-laying period ranges from 105 to 334, the average being 212.

23. The eggs are usually laid in one or two straight rows along the midrib on the upper surface of the leaf at a short distance from the apex.

24. Incubation period in the laboratory was found to range from six to eight days, the average being 7.25 days.

25. The nymph undergoes five molts before the adult emerges, the total nymphal stage occupying a period of seventeen to twenty-three days, and averaging 19.6 days.

26. The principal distinguishing characters between the nymphs and adults, besides the absence of wings and genitalia in the former and relative proportions of segments, are: The odoriferous organs are located in the nymphs between the third

and fourth and fourth and fifth abdominal tergites while in the adult they are on the metathorax. The nymphs have two tarsal segments while the adults have three.

27. The rice bug has two natural enemies in the Philippines—a predaceous tiger beetle, *Cicindela sexpuntata* Fabr., and a Proctotrypioid egg-parasite.

28. The following control measures suggest themselves from the results of the present experiments:

Encouragement of the natural enemies of the insect that are already present here and importation of additional beneficial insects from other rice producing countries.

Regulating rainy-season plantings.

Production of immune or less susceptible strains by breeding and selection.

Trapping.

Catching the adults by an elongated bag dragged across the field, as practiced in India.

Clean culture of the fields during and after the rice season.

Handpicking of eggs.

Spraying with contact insecticides.

ACKNOWLEDGMENTS

I desire to take this opportunity to thank Professor Charles F. Baker for valuable criticisms and suggestions in the preparation of the present paper and for correcting the manuscript in its final form, and Professor Charles S. Banks, who kindly furnished me from time to time during the progress of the work with helpful advice. Grateful acknowledgment is also due to Mr. Severino Aquino, student assistant in entomology, for having faithfully and ably assisted me in the breeding experiments and in the preparation of the line drawings.

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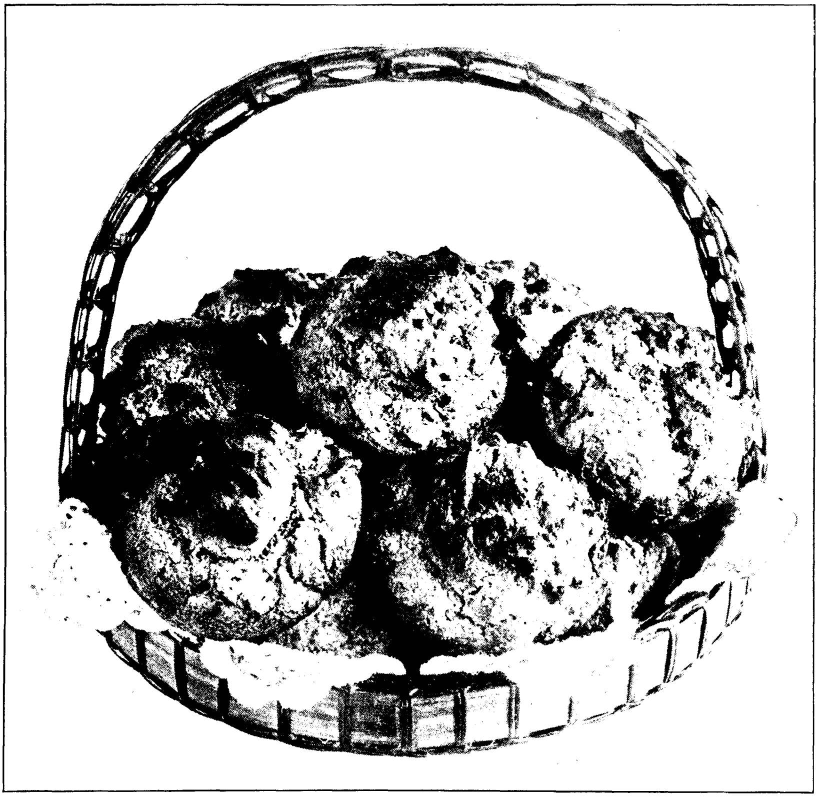

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Agricultural Review

VOL. XIV SECOND QUARTER, 1921 No. 2

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EDITORIAL

By ADRIANO HERNANDEZ, *Director of Agriculture*

Rice has so long continued to be the staff of life in the Philippines, not to say the Oriental tropics, without which existence seemed barely possible, that when the claims of adlay as a grain substitute for rice were first advanced it came as a shock. It did not seem believable. Since then experiments have been made with the grain as a bread stuff which have shown the practicability of using adlay as a substitute for wheat and rice. Laying aside its evident value for the latter purpose, the importance of the discovery of a grain comparable with wheat in quality which can be grown in the tropics can hardly be overestimated. In the Philippines our wheat flour imports have increased within the past decade from 27,700,000 kilos valued at ₱3,013,000 in 1911, to 45,700,000 kilos valued at ₱9,434,000 in 1920. Then, adlay is a dry land as distinguished from a submerged crop. It dispenses with paddies. While this has not yet been done, there is no reason to believe that it cannot be harvested by machinery like wheat and sorghum. This will lower cost of production and give the consumer a cheaper and apparently a better bread stuff.

While in adlay we have a native food plant of merit, the avocado, a fruit of exceptional value from the American tropics is gradually gaining prominence and small orchards are being planted as rapidly as plants are becoming available from home grown and imported seeds, and the people are beginning to like this, one of the best gifts received from America.

The illuminating articles on the little known Island of Mindanao which appeared in this REVIEW last year are in this issue complemented by a general review, which, together with those previously published, it is hoped, will arouse greater interest in the development of the natural resources of that immense and fertile territory, where there is abundant room for the production in large quantities of tropical staples such as rice, sugar, coffee, copra, hemp, and many other crops, under unusually favorable soil and climatic conditions.

AGRICULTURAL CONDITIONS IN THE PHILIPPINES, 1920

By ANTONIO PEÑA, *Chief, Division of Farm Statistics.*[a]

Never before in the history of the Philippine agriculture did the country enjoy a year of greater prosperity nor witnesses a period of more progress than during the agricultural year of 1920, and the results obtained were significant in that not only did the better yields secured show that better methods of farming had been employed but also that the farmers had displayed an unusual amount of fortitude in the face of the adverse weather conditions that prevailed for part of the year, inasmuch as they produced more food crops than ever to help make the country self-supporting. Several typhoons that culminated in extraordinary floods coincident with the time of planting and transplanting rice, and the trancazo epidemic that invaded the whole Archipelago at the beginning of the year, were threatening forces that they bravely defied, replanting the destroyed areas of rice or planting the sugar cane fields to corn, while they worked late into the night to make up for the shortage of hired labor.

During the last ten years, the average annual rate of increase of value of these crops was 16 per cent or ₱35,744,000. Though the two preceding years, 1918 and 1919, showed each a remarkable increase, 1920, despite unfavorable weather conditions registered the surprising and stupendous increase in value of 50 per cent or ₱228,433,000 over that of 1919, which was 27 per cent or ₱96,758,000 greater than 1918, which in turn was 48 per cent or ₱117,761,000 greater than 1917. The average yields per hectare were as a whole 21 per cent greater than those for the preceding five-year period of 1910–14, and those for the single year of 1920 were 4 per cent greater than those for 1915–19, notwithstanding the damage done to crops by typhoons and heavy rains.

VALUE OF SIX LEADING CROPS

High prices, due to the greater needs created by the European War and the dislocation of the world's trade, were a powerful incentive to the farmers to increase the area of their crops; but the actual agricultural prosperity of the Islands was not all, however, due to high prices.

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[a] Extracts from the author's annual report ending December 31, 1920.

The wave of modern knowledge of farming that has flooded other countries has reached and washed away many of the ancient notions and prejudices transmitted from generation to generation. Machines for plowing and threshing are now much in use in the rural districts; seed selection is widely known and practiced by many hacenderos; the up-grading of stock is common, while ordinary farmers now understand the great laws of demand and supply better, and they invest their small savings in rural credit associations, insure their work animals in the Government society and heartily coöperate with it in stamping out pest infestations and plant and animal diseases.

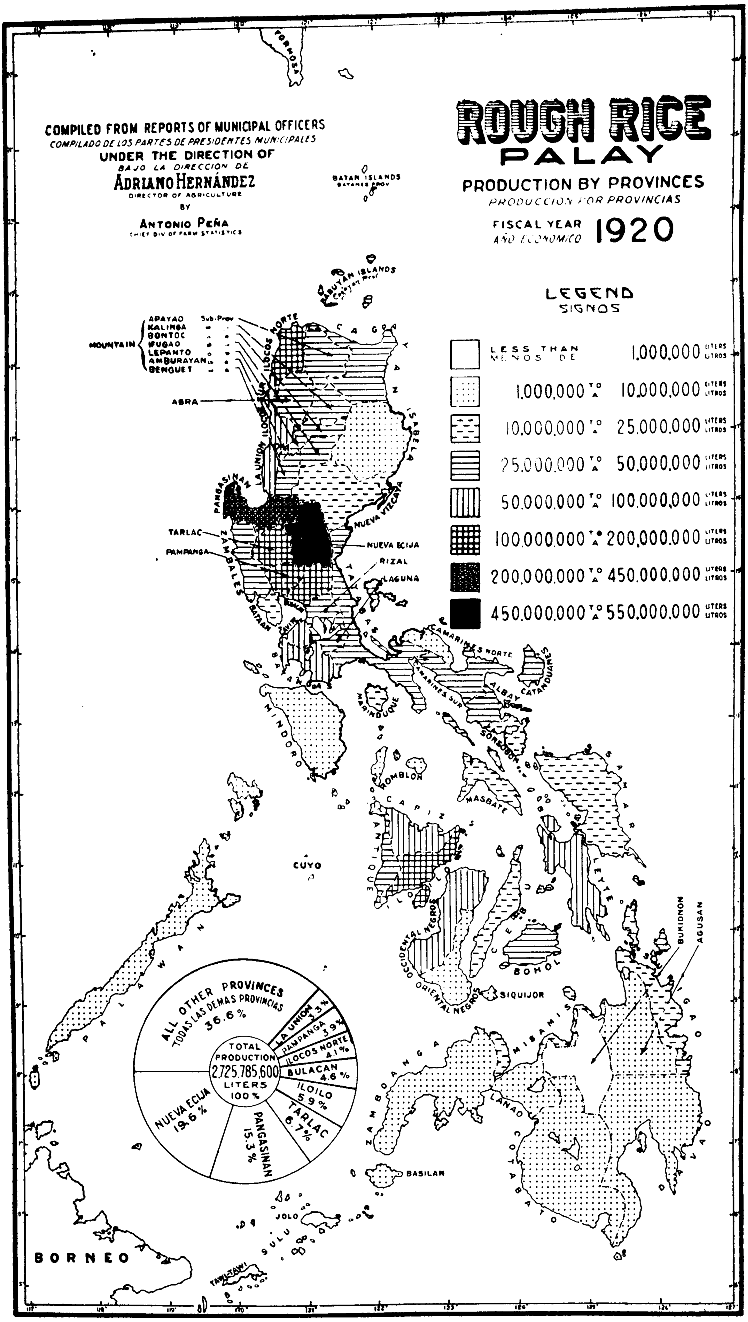
STANDARD CROPS

Rice.—The most notable success of the year for its significance in the economic status of the islands with respect to food, was in the production of rice. For three quarters of a century the production of this cereal has been falling short and of late years this shortage has been growing considerably, as witness the figures for rice importation. But the high prices that have prevailed of late years and other factors that have greatly influenced this industry, as explained in other pages of this report, so strongly stimulated the growers that they succeeded, contrary to early expectations, in gathering a record crop that came very near meeting the local demand.

During 1917 rough rice sold for ₱2.85 per cavan (75 liters). This price advanced to ₱3.77 in 1918, to ₱5.58 in 1919 and to ₱7.01 in 1920. Responsive to this rise in value, plots for many years lying fallow were planted and new lands opened up an increase of 21 per cent in 1920 over the area of 1917, thereby resulting.

TABLE I.—*Rice.—Area cultivated.—Hectares*

1910	1,192,141
1911	1,043,757
1912	1,078,891
1913	1,141,242
1914	1,244,937
1915	1,130,713
1916	1,140,829
1917	1,225,692
1918	1,368,140
1919	1,381,339
1920	1,484,895



Map showing rough rice production by provinces

As aforesaid, serious damage was done to crops by typhoons, heavy rains and floods, and rice was one of the crops most injured, the seedbeds and a considerable area of newly transplanted rice, being destroyed, but the farmers worked strenuously, aided by the field employees of the Bureau of Agriculture, who secured and loaned them seeds to replace the areas destroyed, and the crop was saved with little loss.

The production for 1920 was 2,725,785,600 liters, which was 192,162,000 liters or 8 per cent more than that of the preceding year and 677,524,125 liters or 33 per cent more than the five-year average of 1915–19. This crop sold in the municipal markets brought to the farmers the enormous amount of ₱254,855,385 or 37 per cent more than what they received last year.

The following tables show the annual production of cleaned rice in these Islands for 1910 to 1920 and the importations for the same period (Table II), according to the Customs figures, and the average price per cavan during those years (Table III) Map I shows the distribution of the 1920 crop by provinces.

TABLE II.—*Cleaned Rice.—Kilos*

	Production.	Importation.
1910	528,054,408	184,619,932
1911	574,842,688	203,082,707
1912	325,429,104	260,249,653
1913	685,968,024	179,204,906
1914	636,630,792	81,788,027
1915	498,917,748	175,541,102
1916	584,608,192	183,016,248
1917	791,748,607	179,912,493
1918	1,004,007,385	159,130,511
1919	947,534,047	148,724,258
1920	1,019,399,503	11,018,137

TABLE III.—*Rough rice prices, per cavan (43.6 kilos)*

1910	₱3.01
1911	3.01
1912	3.44
1913	2.36
1914	2.52
1915	2.76
1916	2.68
1917	2.85
1918	3.77
1919	5.58
1920	7.01

Sugar cane.—With a slight decrease of 2,796 hectares or 1 per cent as compared with the preceding year, due to unfavorable weather and the prevalent trancazo epidemic during the planting season, this crop registered, nevertheless, a record figure both in production and value that more than compensated for the loss in hectarage.

TABLE IV.—*Sugar cane.—Area cultivated.—Hectares*

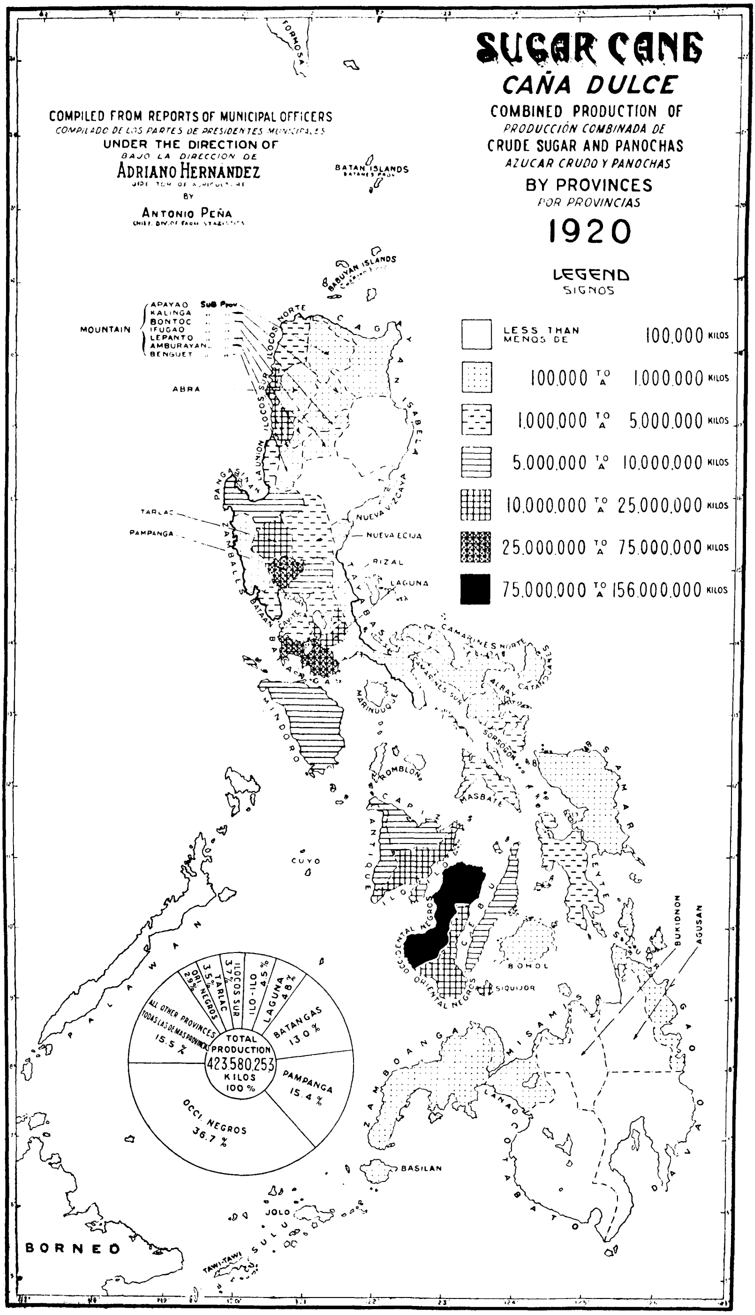
1910	83,168
1911	120,313
1912	164,261
1913	176,118
1914	169,436
1915	173,092
1916	179,761
1917	185,931
1918	205,511
1919	200,199
1920	197,403

The production for 1920 was 423,580,253 kilos of sugar, 3 per cent more than the yield for 1919. It was sold in the municipal markets for ₱159,257,117 a phenomenal increase of 114 per cent over the value obtained last year, largely due to high prices. The following shows the fat profits made during the last few years and especially in 1920.

TABLE V.—*Sugar prices, per picul (63.25 kilos)*

1910	₱6.32
1911	6.32
1912	6.32
1913	5.06
1914	4.75
1915	5.41
1916	5.65
1917	6.20
1918	5.75
1919	11.38
1920	23.66

Of the total production of sugar for this year 53,446 kilos or less than 0.01 per cent refined sugar, 82,555,355 kilos or 20 per cent was centrifugal sugar, 76,983,346 kilos or 18 per cent was muscovado in pilones, 232,270,824 kilos or 55 per cent was muscovado in bayones and 31,717,282 kilos or 7 per cent was panocha. There were besides, 4,095,979 liters of molasses produced and 10,069,812 liters of basi.



Map showing sugar cane production by provinces

TABLE VI.—*Sugar production.—Kilos*

1910	152,639,327
1911	243,924,574
1912	255,243,018
1913	313,051,488
1914	370,442,666
1915	382,102,659
1916	374,012,741
1917	385,798,830
1918	430,685,694
1919	411,272,659
1920	423,580,253

Coconuts.—This is another crop that made a new record during the year, not only as to the number of trees, but also as to the production of copra and the value of its by-products.

At the end of the agricultural year there were 79,406,104 trees planted against 74,650,102 for the previous year. Although there was registered a decrease in the production of the home-made coconut oil, since only 2,879,452 liters were produced this year against 5,142,213 liters that were made in 1919 and the production of tuba declined from 100,315,522 liters gathered in 1919 to 98,068,843 liters in 1920, there was a substantial increase in the production of copra, which more than offset the loss sustained from other by-products. The remarkable reduction in the production of the home-made coconut oil of this year was due to the considerable waste in producing it by crude methods and therefore the expense. Coconut oil factories turn out a comparatively cheap article.

The years' produce of copra was 361,605,373 kilos of which 381,903 kilos are steamed copra, 197,692,998 kilos are smoked copra and 163,530,472 kilos were sundried copra.

TABLE VII.—*Coconuts*

	Trees planted.	Copra production (kilos).
1910	32,838,544	118,140,822
1911	41,695,165	118,323,114
1912	46,136,349	174,035,835
1913	44,642,411	116,699,818
1914	49,190,368	107,382,931
1915	52,829,678	171,573,963
1916	54,153,847	141,764,193
1917	60,244,047	186,510,962
1918	67,120,399	346,656,535
1919	74,650,102	349,384,855
1920	79,406,104	361,605,373

Prices for coconuts for 1920 showed a tremendous income from copra. In 1919 the prices were already high and the aggregate value of all coconut products reached the respectable amount of ₱75,438,291. This year, however, it increased to the phenomenal sum of ₱128,196,891, which means a record increase of 70 per cent over the preceding year.

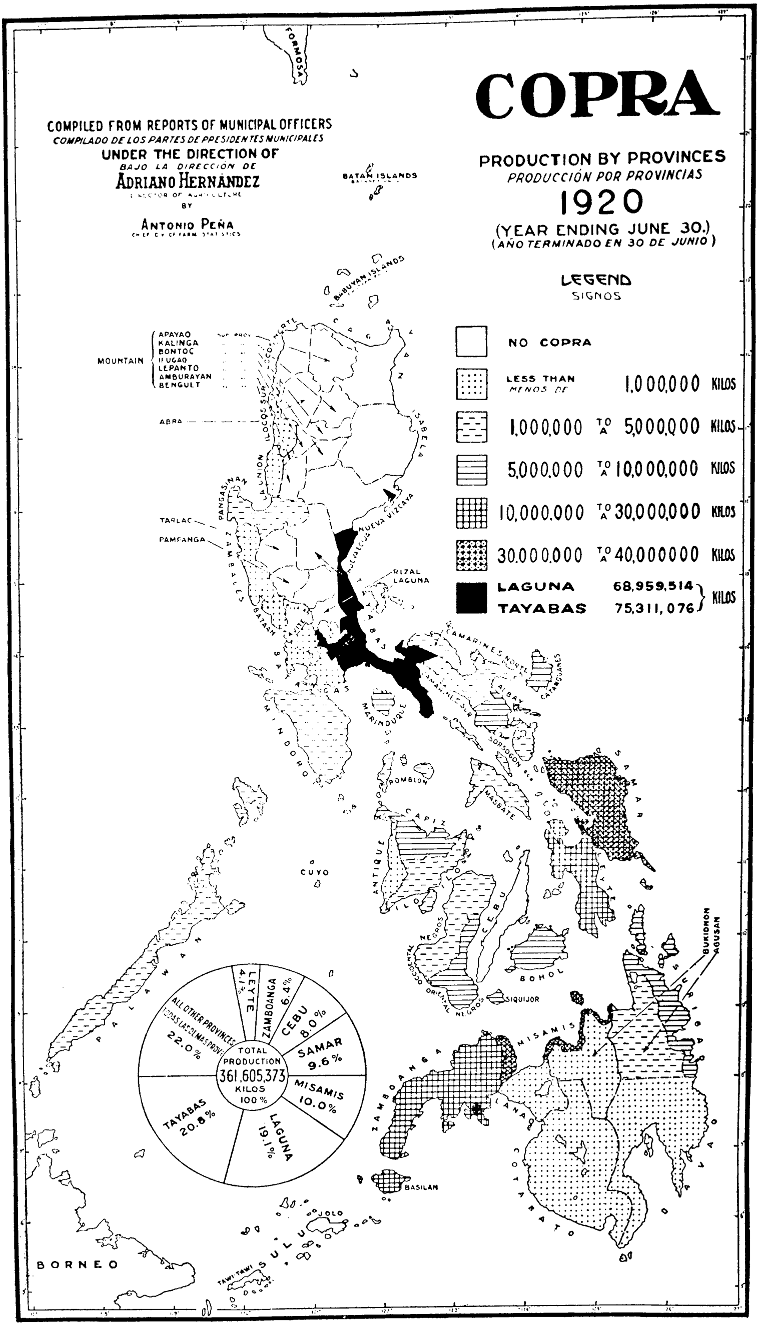
Abacá.—Despite the falling prices, abacá producers have not been much discouraged as they have kept increasing the areas cultivated of this fiber. During the year there were 559,356 hectares cultivated against 515,563 in the preceding year. The low prices this fiber commanded this year is shown by the fact that while the production increased from 148,340,800 kilos in 1919 to 165,081,488 in 1920, the value showed a loss of 3 per cent, as only ₱63,058,847 came to the growers in exchange for their increase of 11 per cent in production.

TABLE VIII.—*Abacá*

	Area cultivated.	Production.	Value.
	Hectares.	*Kilos.*	
1910	475,136	168,452,144	₱26,952,343
1911	404,160	171,879,598	27,500,736
1912	432,804	159,473,376	28,705,208
1913	368,211	140,520,332	32,319,676
1914	437,470	137,635,558	29,968,009
1915	457,865	154,192,492	30,420,742
1916	448,663	152,756,278	42,767,338
1917	488,500	160,953,355	63,598,136
1918	512,508	166,863,644	92,493,224
1919	515,563	148,340,800	65,006,006
1920	559,356	165,081,488	63,058,847

Corn.—Breaking the time-honored rule that a greater production of rice means a smaller production of corn, this year both came together and made a brilliant record crop.

Four hundred thirty thousand seven hundred fifteen hectares were planted last year, yielding 426,456,940 liters of shelled corn which were sold for ₱37,591,423. This year, although heavy rains and typhoons handicapped the work in the fields and damaged the plantations, the farmers put under cultivation 537,135 hectares, gathered 552,907,350 liters and sold for ₱50,910,867. This means that though they paid this year 25 per cent more for cultivating their hectarage, they raised 30 per cent more food and were 35 per cent richer than last year.



Map showing the production of copra by provinces

TABLE IX.—*Corn*

	Area cultivated.	Production.	Value.
	Hectares.	*Liters.*	
1910	288,268	185,068,056	₱8,661,185
1911	302,516	186,404,700	8,723,740
1912	340,196	274,964,929	12,868,359
1913	383,709	325,450,460	15,231,082
1914	421,509	469,961,119	15,873,804
1915	443,048	518,126,873	16,067,658
1916	432,766	496,270,874	14,723,962
1917	428,293	473,659,035	17,639,800
1918	418,386	397,177,773	21,372,123
1919	430,715	426,456,940	37,591,423
1920	537,135	552,907,350	50,910,867

Tobacco.—In the order of value, this crop was always the last among the six leading products. This year it held the same place, but recorded a considerable increase not only in the area cultivated but also in the production and value as well, having obtained the highest percentage in hectarage, the second in production and the fourth in value. Encouraged by the increasingly favorable opinion of Philippine tobacco abroad, the producers raised in 1920, 64,893,534 kilos of leaf tobacco from 101,123 hectares which brought them the substantial amount of ₱26,765,947 against 56,497,748 kilos, 73,859 hectares and ₱17,585,449 respectively for the preceding year. These figures broke previous records by 15 per cent, 37 per cent, and 52 per cent respectively.

TABLE X.—*Tobacco*

	Area cultivated.	Production.	Value.
	Hectares.	*Kilos.*	
1910	53,626	28,006,778	₱4,201,017
1911	69,016	25,518,132	3,827,720
1912	57,041	29,583,169	4,437,475
1913	68,991	46,060,390	6,909,059
1914	60,890	46,731,463	7,109,367
1915	53,342	38,302,964	5,684,579
1916	58,913	41,139,174	7,259,169
1917	61,776	48,928,621	10,883,523
1918	78,443	61,555,322	15,219,155
1919	73,859	56,497,748	17,585,449
1920	101,123	64,893,534	26,765,947

Maguey.—Because of the increasing demand for substitutes for fibers of higher values, the maguey crop made this year a record in hectarage, production, and value. The hectarage for this year was 30,567 against 28,465 in 1919 and the produce was 18,178,050 kilos worth ₱3,407,959. Compared with the previous year, when the production was 12,318,392 kilos and the value ₱1,919,750, this crop registered a 7 per cent increase in the area cultivated, 47 per cent in the production, and 78 per cent in the value—one of the highest percentages of increase among the leading products.

TABLE XI.—*Maguey*

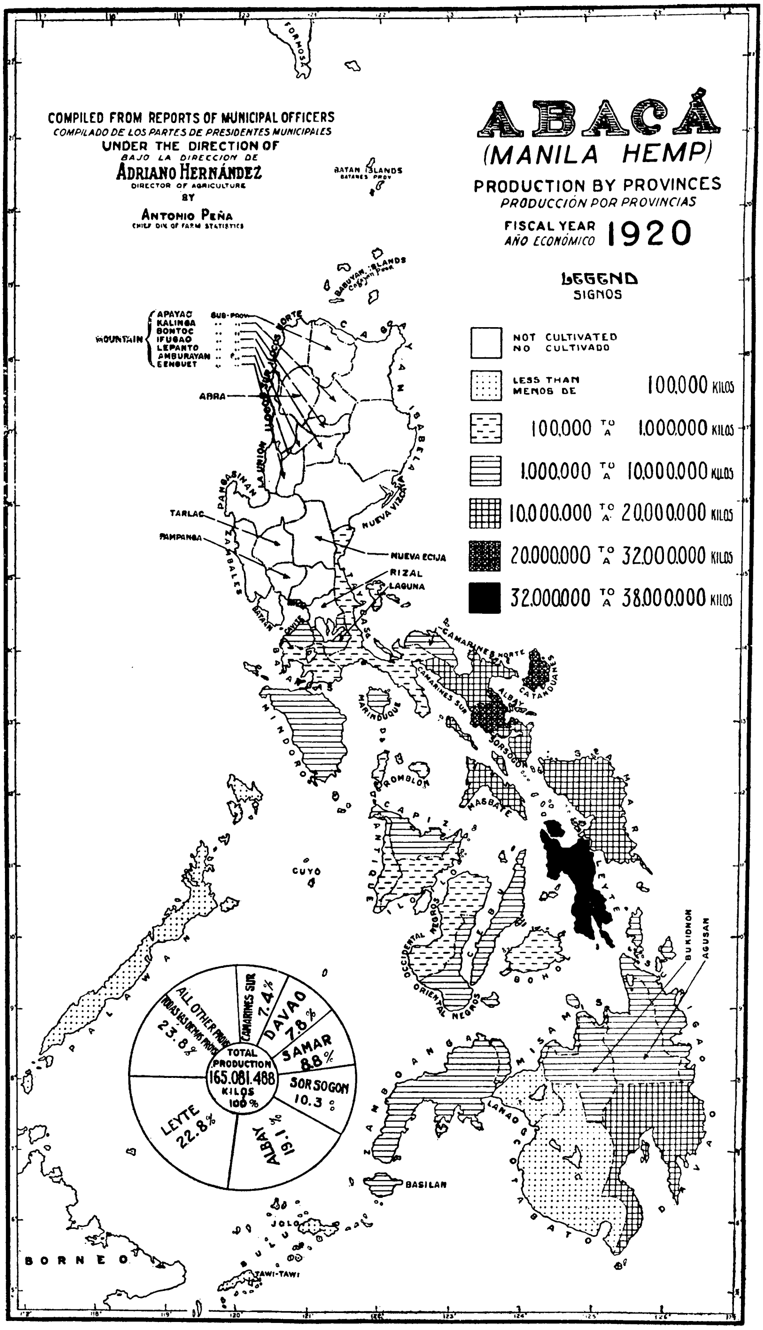
	Area cultivated.	Production.	Value.
	Hectares.	*Kilos.*	
1912	8,598	4,628,331	₱555,399
1913	9,283	3,619,976	470,596
1914	18,218	7,583,802	860,754
1915	19,218	6,315,632	622,587
1916	30,804	13,389,722	1,747,263
1917	28,099	17,190,019	3,363,381
1918	32,601	16,664,736	3,707,213
1919	28,465	12,318,392	1,919,750
1920	30,567	18,178,050	3,407,959

Cacao and coffee.—These two crops registered this year the greatest yield of the past decade. Raised practically for home consumption, both are bound to hold a prominent place, for the natives are great consumers of coffee and chocolate, and import large amount every year.

There were found to be 1,871,700 cacao trees planted yielding 823,500 kilos and 2,015,200 coffee trees producing 998,800 kilos worth nearly two million pesos. There was an increase for cacao of 1 per cent in the number of trees and of 44 per cent in the production; and for coffee, of 4 per cent in the trees and of 34 per cent in the production. The status of both crops since 1914 is given in the following tables:

TABLE XII.—*Cacao*

	Trees planted.	Production.	Value.
		Kilos.	
1914	1,868,864	565,802	₱354,057
1915	1,869,685	625,611	398,991
1916	1,719,534	558,357	345,059
1917	1,618,010	537,335	338,500
1918	1,827,923	566,200	520,670
1919	1,853,183	572,740	535,053
1920	1,871,700	823,500	924,700



Map showing abacá production by provinces

TABLE XIII.—*Coffee*

	Trees planted.	Production. *Kilos.*	Value.
1914	1,969,996	626,408	₱302,771
1915	2,098,200	694,864	342,153
1916	2,110,974	752,196	361,754
1917	1,650,295	594,620	281,590
1918	1,920,571	721,855	445,983
1919	1,931,580	717,233	514,338
1920	2,015,200	998,800	823,800

Miscellaneous field crops and vegetables.—Though this was the first time that data on vegetables and root crops were gathered and comparison with other years is therefore impossible, and though little of these crops is grown commercially, the aggregate area planted thereto this year and the income derived therefrom was considerable. One hundred thirty-eight thousand seven hundred twenty-two hectares cultivated to different crops brought to the farmers the fat sum of ₱11,775,800. Considering the losses sustained by these crops on account of unfavorable climatic conditions and the waste because of home-growing methods, the income is quite satisfactory.

The most important among these crops were, sweet potatoes widely known as "camotes" and largely consumed as a substitute for rice and corn and the chief food of mountain races; cassava, or tapioca plant, a most valuable food; mongo, eaten by people and hogs; and gabi, rated next to the sweet potatoes among the chief food products. To these four crops alone, there were 113,007 hectares planted with the value of ₱8,615,100, and a production of 177,192,000 kilos for sweet potatoes, 21,592,000 kilos for cassava, 6,932,200 kilos for mongo, and 27,687,800 kilos for gabi.

The following table shows the areas planted to nine selected vegetable and root crops and the value of each for the year 1920.

TABLE XIV.—(*Revised*)

Crops.	Area cultivated. *Hectares.*	Value in pesos.
Beans	6,978	684,700
Cassava	10,628	1,502,200
Gabi	10,428	1,213,800
Mongo	26,777	1,504,000
Peanuts	5,702	617,500
Sweet potatoes	65,174	4,395,100
Tomatoes	6,690	766,400
Tugui	1,778	350,200
Ubi	4,567	741,900
Total	138,722	11,775,800

Fruit production.—As with vegetables, the figures for fruit trees of this year are the first ever gathered by the Bureau of Agriculture. Figures for eleven different kinds of fruits are presented herein, and while only some of the fruits have commercial value as yet, a promising future is awaiting the rest. The leading fruits were bananas, with 39,321,300 bunches sold for ₱15,887,800; mangoes, one of the most delicious and prized fruits of the world, of which 120,305,900 were marketed for ₱3,368,900. Lanzones, another delicate and refreshing fruit, brought to the growers ₱1,999,700, and papayas yielded produce to the value of ₱905,900.

The following shows the aggregate value of eleven selected fruits.

TABLE XV.—(*Revised*)

	Value.
Bananas	15,887,800
Cacao	924,700
Chicos	120,500
Coffee	823,800
Lanzones	1,999,700
Mandarin	231,400
Mangoes	3,368,900
Oranges	258,500
Papayas	905,900
Pilinut	398,300
Pineapple	402,800
Total	25,322,300

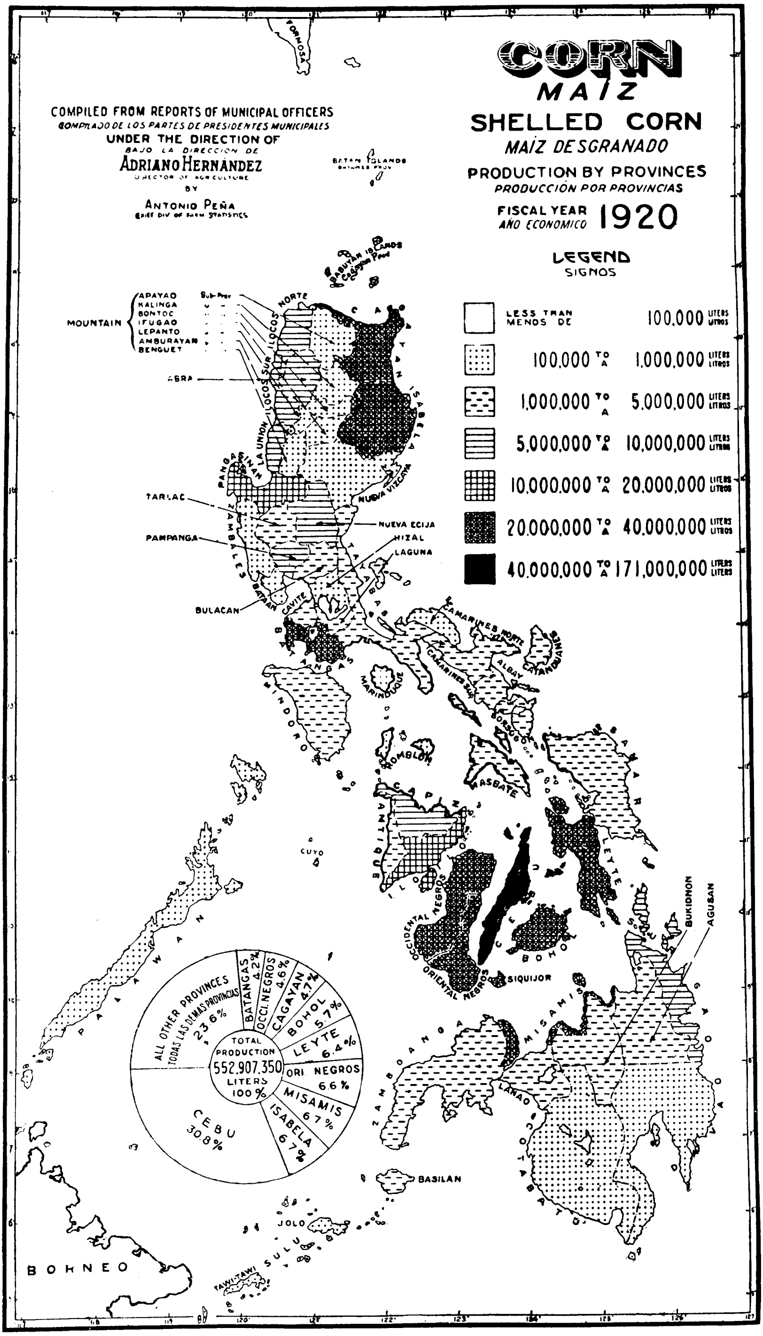
LIVESTOCK

Owing to the short time available between the end of the year and the writing of this report, it is not possible to present figures regarding livestock for an earlier period than that ending December 31, 1919, and therefore, the following figures are for that year. Statistics for 1920 will be furnished a little later.

With the one exception of goats, all other animals—carabaos, cattle, horses, hogs, and sheep, registered for 1919 showed increase over the preceding year.

Contrary to common belief these increases have been registered continually since 1910, despite serious epidemics of epizootic diseases excepting only one year, in 1916, for horses, 1918 for cattle, and 1919 for goats.

That the current belief that animals have decreased due to continuous and long infestations is groundless, is proven by the figures on records, which show that since 1910, the carabaos have increased by 96 per cent, cattle by 178 per cent, horses by



Map showing corn production by provinces

79 per cent, hogs by 90 per cent, goats by 73 per cent, and sheep by 89 per cent, all during the course of only nine years.

The rate of mortality because of disease during 1919 was 20.4 per 1,000 for carabaos, 38.4 per 1,000 for cattle, 40.4 per 1,000 for horses, 45.8 per 1,000 for hogs, 35.0 per 1,000 for goats, and 35.8 per 1,000 for sheep. If compared with the previous year 1918, there is gain in favor of 1919 of 1 per 1,000 for carabaos, 3.1 per 1,000 for hogs, 10.8 per 1,000 for goats, and 4.8 per 1,000 for sheep, and a loss of 3 per 1,000 for cattle and 8.1 per 1,000 for horses.

Comparing the relative deaths of both years, figures show a better control of diseases during 1919, because with a larger number of heads, there was a general decrease in the number of deaths of 27 per cent from 1918 of carabaos, 4 per cent of cattle, horses, and hogs, 48 per cent of goats, and 30 per cent of sheep.

On the other hand, there was, with the one exception of cattle, a general decrease in the rate of natality during 1919. This is due to the fact that the high prices paid for livestock are tempting the owners, who send to the markets more grown animals than they should, thereby decreasing their available stock for reproduction.

As long as this practice continues to decrease the size of the herds, the livestock industry is bound to remain stagnant.

TABLE XVI

	Carabaos.	Cattle.	Horses.	Hogs.	Goats.	Sheep.
1910	705,758	243,180	138,199	1,637,338	422,185	88,805
1911	809,267	289,771	146,641	1,661,931	441,325	92,617
1912	911,318	337,202	162,383	1,735,047	476,638	97,640
1913	1,047,164	418,114	179,089	2,016,736	529,180	104,147
1914	1,147,433	477,736	215,826	2,285,880	592,042	118,010
1915	1,221,966	534,123	223,195	2,521,143	644,562	129,509
1916	1,228,836	567,456	203,364	2,734,803	661,859	142,091
1917	1,271,208	603,107	214,209	2,810,737	722,532	155,827
1918	1,338,082	601,297	234,041	2,894,403	741,077	165,686
1919	1,388,244	678,525	255,380	3,129,676	731,849	168,181

AGRICULTURAL PROSPECTS

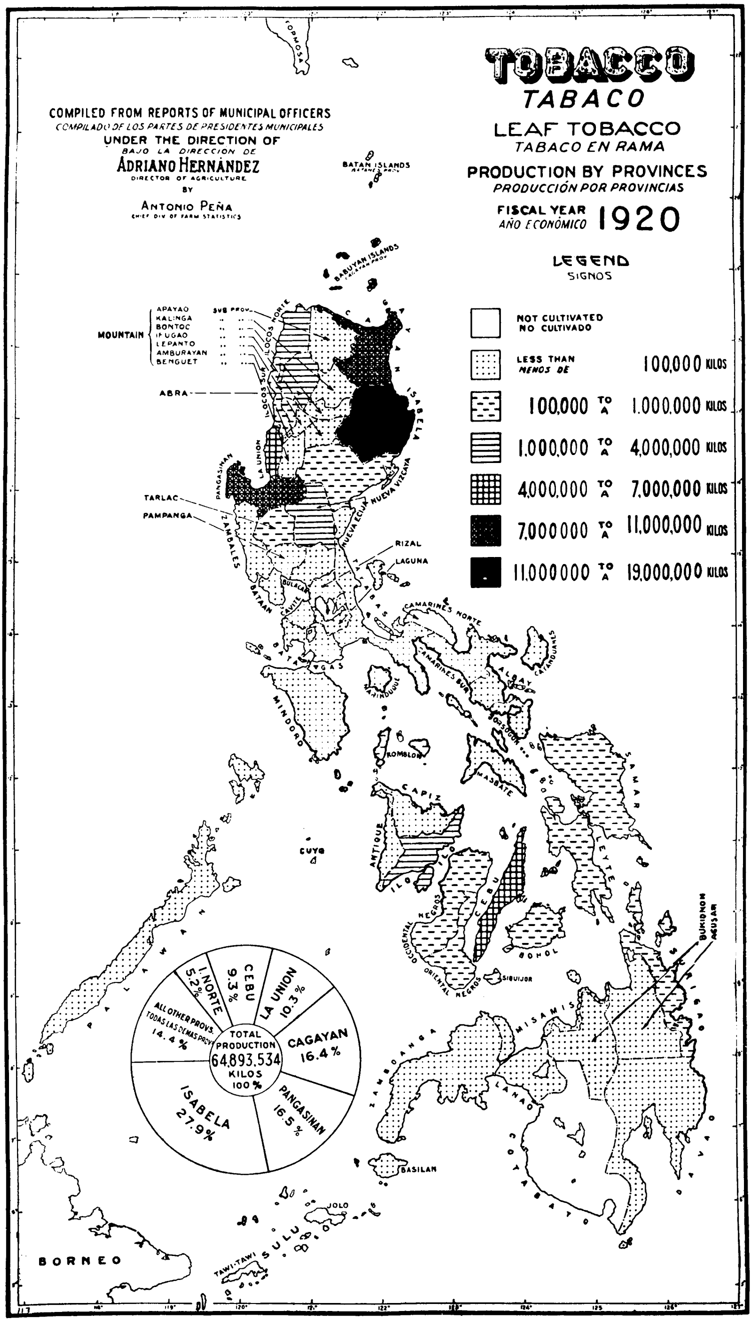
Paradoxical as it may appear, the European War caused a sudden and pronounced development of agriculture in these Islands. The reduction in the supply of foodstuffs and raw materials and the interruption of the oversea routes the world over, coupled with the destruction and waste resulting from the war, created a considerable great demand for supplies, which was not overlooked by our farmers.

The year 1920 registered phenomenal increases both in the production and value of practically all crops, due largely to the higher prices that these commanded. As prices were still rising when the planting season of sugar cane, rice, and corn began the growers extended the already augmented areas under cultivation in the face of such difficulties as shortage of cane points, labor and heavy rains and floods. As a result of their diligence of 1921 will probably see a new record in crops. The year 1920 witnessed the largest rice crop ever gathered in the Islands, but 1921 will beat it by 5 per cent if nothing unfavorable happens before the harvest. There is hope for 38,144,528 cavans of rough rice or 1,019,399,503 kilos of cleaned rice.

And if this flattering hope is entertained with the rice crop, it is incomparable with what is expected from sugar cane. No effort has been spared; new lands have been opened up, rice and corn lands have been planted to sugar cane, every bit of energy has been employed to increase the crop, and in fact, if present indications do not fail, they will succeed beyond measure. Indeed it is feared by some that the mills now operating will not be able to handle the cane that will be gathered.

The production for 1918 was the highest on record—430,685,694 kilos, but it is predicted that the production for 1921 will be 552,027,000 kilos which is 28 per cent more than the highest record and 30 per cent more than the 1920 figures.

With a much lower output but one none the less flattering, the copra production for 1921 promises to break all records made. To the number of trees actually bearing there will be 3,000,000 more added this year and if the 1920 conditions prevail, it is believed that the production of copra will be 381,338,000 kilos, or 5 per cent greater over the 1920 crop.



Map showing tobacco production by provinces

To crown all these brilliant prospects there comes corn with an area for 1921 greatly extended by approximately 20,000 hectares over the preceding year. Although seriously affected by adverse weather conditions in some districts the increase in area will be more than enough to offset this loss and still make a substantial gain. According to latest information, this grain will yield 7,875,000 cavans or 7 per cent over the highest record of last year.

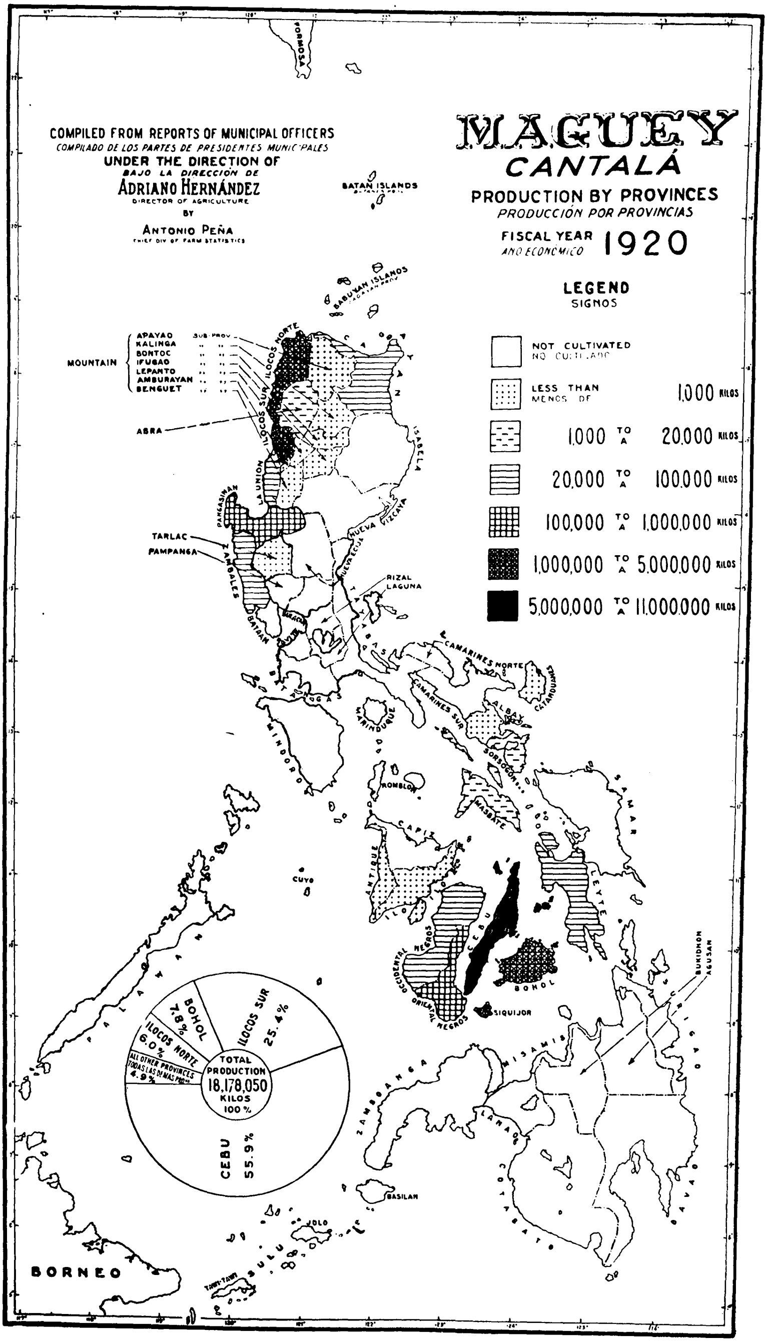
Abacá is the only exception. Declining prices have discouraged most farmers, who will most probably turn their attention to other and better paying crops. Accordingly it is presumed that the production of this important fiber will suffer a loss of 20 per cent, or 132,000,000 kilos.

Opposed to this brilliant prospect from the combined efforts of man and nature to make the land produce lies the uncertain factor of the falling price of rice.

For three quarters of a century the Philippines have been depending upon foreign countries to make good the usual annual shortage. The reasons for this can be traced to the successful growing of the main Philippine export crops. The chief producing provinces in the Islands are located in the regions having a distinct dry season and can not, therefore, raise but one crop a year. The cultivation of rice requires much labor, and with the lack of work animals and hands, the absence of adequate systems of irrigation, and modern methods of harvesting, the yields are low and the cost of production very high. On the contrary, the plentiful labor of Indo-China and Siam, from which the Philippines import rice, makes for low cost of rice production therein, and considering the large amount they raise and the usual low rate of exchange, it is more profitable for the Philippines to import foreign rice even with the present high freight charges than to produce it locally, so the merchants do import large quantities. As the rice prices prevailing in the Islands are regulated by the price of foreign rice, and the local growers can not compete with these prices, they turn their attention to the export crops, and this will likewise take place as soon as the pre-war prices come back, unless proper measures are taken to maintain the present high production.

TABLE XVII.—*Rough rice statistics for the Philippine Islands for the year ending June 30, 1920*

Rank.	Provinces.	Area cultivated.	Production.	Average production per hectare.	Average price per liter in municipal markets.	Total value of rough rice in municipal markets.
		Hectares.	*Liters.*	*Liters.*		
24	Abra	16,217	29,468,625	1,817	₱0.104	₱3,075,599
43	Agusan	2,499	3,230,100	1,292	.087	280,309
18	Albay	29,003	43,350,900	1,495	.102	4,436,502
17	Antique	31,524	44,584,350	1,414	.072	3,188,921
28	Bataan	9,157	20,745,900	2,266	.094	1,959,143
47	Batanes	64	53,550	837	.099	5,304
14	Batangas	37,500	50,260,425	1,340	.111	5,575,531
22	Bohol	35,904	37,488,975	1,044	.095	3,570,040
45	Bukidnon	1,020	887,100	870	.062	54,864
5	Bulacan	59,867	124,511,250	2,080	.094	11,718,468
19	Cagayan	25,206	41,681,325	1,654	.099	4,124,940
37	Camarines Norte	4,850	5,641,800	1,163	.093	525,614
15	Camarines Sur	33,143	47,605,725	1,436	.095	4,531,526
10	Capiz	44,831	70,628,925	1,575	.082	5,786,550
11	Cavite	36,494	65,030,100	1,782	.102	6,652,687
33	Cebu	7,290	10,122,825	1,389	.100	1,013,731
44	Cotabato	1,864	2,216,775	1,189	.068	150,371
40	Davao	4,319	4,401,225	1,019	.082	362,149
6	Ilocos Norte	74,059	110,975,325	1,498	.095	10,552,879
9	Ilocos Sur	45,235	71,291,175	1,576	.111	7,882,528
4	Iloilo	121,630	160,211,250	1,317	.104	16,699,626
39	Isabela	3,073	5,207,325	1,695	.175	912,561
16	Laguna	23,475	47,190,975	2,010	.097	4,585,459
41	Lanao	3,661	4,347,375	1,187	.096	418,320
8	La Union	50,930	90,799,500	1,783	.107	9,721,508
12	Leyte	38,435	62,525,100	1,627	.105	6,573,043
29	Marinduque	14,974	16,138,575	1,078	.099	1,599,358
34	Mindoro	5,665	9,606,600	1,696	.072	694,075
30	Misamis	8,354	14,474,100	1,733	.078	1,130,446
25	Mountain	26,344	28,398,600	1,078	.100	2,831,458
1	Nueva Ecija	162,471	535,229,625	3,294	.085	45,320,973
32	Nueva Vizcaya	6,317	13,174,350	2,086	.066	863,621
13	Occidental Negros	41,628	52,679,925	1,265	.099	5,196,405
36	Oriental Negros	4,952	7,502,550	1,515	.067	504,131
42	Palawan	3,249	3,932,250	1,210	.073	285,103
7	Pampanga	65,568	105,636,600	1,611	.095	10,035,457
2	Pangasinan	179,393	416,767,350	2,323	.092	38,162,189
21	Rizal	25,310	39,864,150	1,575	.095	3,779,151
35	Romblon	6,786	7,747,125	1,142	.099	770,935
27	Samar	15,711	22,146,675	1,410	.097	2,147,755
31	Sorsogon	13,318	13,977,375	1,049	.107	1,502,406
46	Sulu	833	750,000	900	.080	60,300
26	Surigao	16,664	23,757,150	1,426	.127	3,007,359
3	Tarlac	87,772	182,796,975	2,083	.084	15,437,924
20	Tayabas	29,995	40,381,275	1,346	.097	3,912,432
23	Zambales	23,373	31,038,000	1,328	.092	2,857,467
38	Zamboanga	4,967	5,328,450	1,073	.075	398,267
	Philippine Islands	1,484,895	2,725,785,600	....	....	254,855,385
	Average	....	....	1,836	.093	....



Map showing maguey production by provinces

TABLE XVIII.—*Shelled corn statistics for the year ending June 30, 1920*

Rank.	Provinces.	Area cultivated.	Production.	Average production per hectare.	Average price per liter.	Total value.
		Hectares.	*Liters.*	*Liters.*		
13	Abra	10,015	8,427,150	825	₱0.059	₱499,912
30	Agusan	2,196	1,820,850	825	.073	133,071
26	Albay	3,429	2,553,225	750	.105	267,271
27	Antique	2,287	2,135,025	900	.086	184,017
35	Bataan	1,013	836,175	825	.096	80,152
47	Batanes	57	92,550	1,650	.092	8,550
9	Batangas	23,364	23,223,075	975	.079	1,841,004
6	Bohol	28,835	31,777,200	1,125	.086	2,738,319
34	Bukidnon	1,127	1,001,250	825	.076	75,550
21	Bulacan	6,239	4,317,450	675	.093	399,441
7	Cagayan	22,062	25,936,350	1,125	.079	2,040,625
44	Camarines Norte	285	228,450	825	.091	20,861
31	Camarines Sur	1,527	1,688,475	1,125	.087	146,114
14	Capiz	8,256	8,162,325	1,050	.083	680,171
22	Cavite	5,028	3,692,025	750	.101	372,928
1	Cebu	162,670	170,266,875	1,050	.093	15,889,670
42	Cotabato	537	406,200	750	.059	24,138
40	Davao	896	661,125	750	.096	63,250
16	Ilocos Norte	7,928	7,425,900	900	.089	660,122
15	Ilocos Sur	9,031	7,671,375	825	.102	785,869
11	Iloilo	20,130	13,747,650	675	.091	1,261,780
2	Isabela	33,574	37,167,975	1,125	.098	3,656,199
33	Laguna	1,403	1,056,225	750	.072	90,123
29	Lanao	1,750	1,874,175	1,050	.084	156,759
17	La Union	5,916	6,479,400	1,125	.118	648,702
5	Leyte	29,594	35,553,150	1,200	.096	3,405,240
46	Marinduque	203	175,125	825	.069	12,005
32	Mindoro	1,062	1,185,150	1,050	.104	123,125
3	Misamis	24,846	36,920,850	1,425	.089	3,286,760
38	Mountain	1,680	732,075	450	.069	50,737
19	Nueva Ecija	5,062	5,619,225	1,125	.089	500,318
41	Nueva Vizcaya	513	613,050	1,200	.063	38,886
8	Occidental Negros	23,306	25,308,750	1,050	.101	2,563,930
4	Oriental Negros	39,106	36,414,750	900	.095	3,460,511
43	Palawan	287	315,075	1,125	.129	40,618
12	Pampanga	12,238	8,846,325	675	.108	957,341
10	Pangasinan	12,985	14,964,525	1,125	.10	1,497,307
37	Rizal	1,011	739,275	675	.099	73,015
36	Romblon	816	741,450	900	.089	66,167
23	Samar	3,651	3,254,700	900	.116	377,505
24	Sorsogon	3,321	2,689,125	825	.088	237,893
45	Sulu	235	193,875	825	.075	14,476
18	Surigao	5,759	5,622,750	975	.076	425,119
25	Tarlac	2,838	2,572,500	900	.095	245,258
28	Tayabas	3,115	2,132,775	675	.106	226,618
29	Zambales	1,035	711,675	675	.091	64,675
26	Zamboanga	4,917	4,952,700	975	.105	518,770
	Total Philippine Islands	537,135	552,907,350	....	....	50,910,867
	Average	....	....	1,050	.092	....

TABLE XIX.—*Sugar cane statistics, year ending June 30, 1920*

Rank.	Provinces.	Area cultivated.	Products derived from sugar cane.			
			Sugar.		Panocha.	
		Hectares.	Kilos.	Piculs.	Kilos.	Piculs.
27	Abra	525	31,815	503	524,785	8,297
42	Agusan	16	...	...	10,752	170
34	Albay	319	...	...	126,437	1,999
10	Antique	3,244	6,458,331	102,108	2,530	40
18	Bataan	1,892	3,100,515	49,020	...	...
43	Batanes	32	...	...	7,274	115
3	Batangas	24,750	55,073,609	870,729	6,199	98
26	Bohol	687	88,550	1,400	642,683	10,161
39	Bukidnon	93	...	...	30,044	475
12	Bulacan	5,134	5,435,768	85,941	17,330	274
33	Cagayan	114	88,550	1,400	43,326	685
36	Camarines Norte	167	...	...	104,615	1,654
23	Camarines Sur	1,132	...	...	921,806	14,574
14	Capiz	1,575	3,843,260	60,763	1,220,409	19,295
16	Cavite	2,527	3,564,770	56,360	949,130	15,006
13	Cebu	2,720	4,800,169	75,892	623,582	9,859
41	Cotabato	11	...	...	12,270	194
..	Davao	...	...	...	...	...
21	Ilocos Norte	3,367	...	...	1,535,204	24,272
6	Ilocos Sur	5,524	14,851,037	234,799	612,386	9,682
5	Iloilo	9,620	18,474,123	292,081	640,596	10,128
44	Isabela	181	...	...	949	15
4	Laguna	9,789	13,354,036	211,131	7,131,501	112,751
32	Lanao	140	139,782	2,210	42,314	669
15	La Union	2,940	1,839,626	29,085	3,042,705	48,106
19	Leyte	1,081	4,111	65	2,171,942	34,339
40	Marinduque	39	...	...	16,065	254
9	Mindoro	1,992	8,275,251	130,834	22,770	360
35	Misamis	71	9,487	150	111,510	1,763
24	Mountain	2,134	...	...	890,497	14,079
20	Nueva Ecija	1,109	215,493	3,407	1,493,839	23,618
37	Nueva Vizcaya	106	...	...	55,976	885
1	Occidental Negros	60,419	155,625,423	2,460,481	...	...
8	Oriental Negros	3,854	12,383,844	195,792	2,087	83
38	Palawan	49	...	...	55,850	888
2	Pampanga	33,734	63,883,955	1,010,023	1,280,180	20,240
11	Pangasinan	3,763	4,480,314	70,835	1,410,222	22,296
17	Rizal	2,535	2,423,297	38,313	1,450,259	22,929
..	Romblon	...	...	...	...	...
31	Samar	338	...	...	243,449	3,849
22	Sorsogan	985	...	...	1,091,695	17,260
..	Sulu	...	...	...	...	...
25	Surigao	475	...	...	741,416	11,722
7	Tarlac	7,340	13,389,772	211,696	1,309,844	20,709
29	Tayabas	408	7,590	120	313,341	4,954
30	Zambales	295	20,493	324	293,923	4,647
28	Zamboanga	177	...	...	513,590	8,120
	Philippine Islands	197,403	391,862,971	6,195,462	31,717,282	501,459

TABLE XIX.—*Sugar cane statistics, year ending June 30, 1920*—Continued

Provinces.	Products derived from sugar cane.		Average price in the municipal markets.					
	Basi.	Molasses.	Sugar per—		Panocha per—		Basi.	Molasses.
	Liters.	Liters.	Kilo.	Picul.	Kilo.	Picul.	Liter.	Liter.
Abra	477,376	184,646	₱0.18	₱11.41	₱0.12	₱7.37	₱0.23	₱0.25
Agusan	......	24,636	......	......	.12	7.59	......	.20
Albay	77,665	180	......	......	.18	11.48	.11	.38
Antique	......	8,086	.36	22.98	.19	12.00	......	.20
Bataan	......	......	.40	25.26	......	......	......	......
Batanes	121,976	......	......	......	.19	12.00	.06	......
Batangas	......	679,900	.33	21.03	.40	25.50	......	.14
Bohol	......	......	.36	22.81	.34	21.60	......	......
Bukidnon	......	285	......	......	.31	19.50	......	.12
Bulacan	......	65,615	.41	25.90	.36	23.00	......	.14
Cagayan	1,506,978	1,300	.24	15.00	.11	7.11	.34	.28
Camarines Norte	......	1,600	......	......	.24	14.89	......	.20
Camarines Sur	14,751	3,670	......	......	.19	12.23	.12	.24
Capiz	......	200	.41	25.65	.34	21.67	......	.30
Cavite	......	6,550	.33	21.17	.42	26.59	......	.25
Cebu	......	47,595	.41	25.98	.35	21.90	......	.20
Cotabato	......	200	......	......	.15	9.26	......	.50
Davao	......	......	......	......	......	......	......	......
Ilocos Norte	3,861,220	908,634	......	......	.22	14.16	.16	.21
Ilocos Sur	1,830,012	122,330	.31	19.46	.26	16.29	.26	.40
Iloilo	......	500	.42	26.75	.38	24.00	......	.30
Isabela	210,560	51,800	......	......	.19	12.00	.20	.39
Laguna	......	23,448	.44	27.99	.33	20.66	......	.08
Lanao	......	......	.36	22.74	.12	7.61	......	......
La Union	625,268	58,810	.23	14.51	.24	14.95	.32	.54
Leyte	......	......	.37	23.45	.24	15.05	......	......
Marinduque	......	......	......	......	.18	11.27	......	......
Mindoro	......	973,256	.53	33.27	.45	28.44	......	.05
Misamis	......	......	.24	15.00	.36	23.10	......	......
Mountain	197,880	10,980	......	......	.25	16.02	.20	.18
Nueva Ecija	184,092	16,022	.39	24.92	.27	17.00	.12	.17
Nueva Vizcaya	31,152	21,805	......	......	.48	30.06	.22	.28
Occidental Negros	......	50,000	.38	24.12	......	......	......	.05
Oriental Negros	......	......	.43	27.30	.18	11.09	......	......
Palawan	......	......	......	......	.10	8.83	......	......
Pampanga	......	224,914	.36	22.90	.39	24.94	......	.20
Pangasinan	667,232	412,080	.39	24.90	.32	20.22	.45	.25
Rizal	......	36,370	.45	28.23	.38	23.79	......	.21
Romblon	......	......	......	......	......	......	......	......
Samar	......	......	......	......	.32	20.40	......	......
Sorsogon	......	971	......	......	.39	24.67	......	.40
Sulu	......	......	......	......	......	......	......	......
Surigao	460	200	......	......	.31	19.46	.12	.50
Tarlac	259,920	137,539	.28	17.90	.26	16.37	.34	.43
Tayabas	1,450	18,999	.32	20.00	.27	17.21	.17	.43
Zambales	1,820	2,858	.37	23.70	.30	18.71	.28	.30
Zamboanga	......	......	......	......	.31	19.91	......	......
Philippine Islands	10,069,812	4,095,979	.37	23.66	.30	18.95	.24	.18

TABLE XIX.—*Sugar cane statistics, year ending June 30, 1920*—Continued

Provinces.	Value of sugar cane products in the municipal markets.				Total value.
	Sugar.	Panocha.	Basi.	Molasses.	
Abra	5,742	61,138	107,819	46,172	₱220,871
Agusan	...	1,290	...	4,927	6,217
Albay	...	22,951	8,481	69	31,501
Antique	2,345,990	480	...	1,617	2,348,087
Bataan	1,238,202	...	...	...	1,238,202
Batanes	...	1,380	7,141	...	8,521
Batangas	18,309,146	2,499	...	97,485	18,409,130
Bohol	31,930	219,479	...	...	251,409
Bukidnon	...	9,263	...	34	9,297
Bulacan	2,225,820	6,302	...	9,166	2,241,288
Cagayan	21,000	4,800	498,514	360	524,674
Camarines Norte	...	24,628	...	320	24,948
Camarines Sur	...	178,291	1,747	894	180,932
Capiz	1,558,358	418,096	...	60	1,976,514
Cavite	1,192,925	399,040	...	1,638	1,593,603
Cebu	1,971,804	215,865	...	9,519	2,197,188
Cotabato	...	1,796	...	100	1,896
Davao	...	...	...	...	...
Ilocos Norte	...	343,702	610,760	188,005	1,142,467
Ilocos Sur	4,569,547	157,705	474,795	48,864	5,250,911
Iloilo	7,813,648	243,072	...	150	8,056,870
Isabela	...	180	42,100	20,480	62,760
Laguna	5,910,468	2,329,846	...	1,876	8,242,190
Lanao	50,250	5,091	...	...	55,341
La Union	422,066	719,003	202,630	31,727	1,375,426
Leyte	1,524	516,911	...	...	518,435
Marinduque	...	2,864	...	...	2,864
Mindoro	4,352,334	10,240	...	48,663	4,411,237
Misamis	2,250	40,718	...	...	42,968
Mountain	...	225,488	40,432	1,966	267,886
Nueva Ecija	84,915	401,528	22,711	2,659	511,813
Nueva Vizcaya	...	26,606	6,817	8,254	41,677
Occidental Negros	59,352,003	...	...	2,500	59,354,503
Oriental Negros	5,345,876	366	...	...	5,346,242
Palawan	...	5,589	...	...	5,589
Pampanga	23,136,384	504,800	...	44,374	23,685,558
Pangasinan	1,763,915	450,893	302,588	102,644	2,620,040
Rizal	1,081,560	545,570	...	7,724	1,634,854
Romblon	...	...	...	...	...
Samar	...	78,526	...	...	78,526
Sorsogon	...	425,848	...	393	426,241
Sulu	...	...	...	...	...
Surigao	...	228,193	56	100	228,349
Tarlac	3,788,654	339,070	89,183	59,375	4,276,282
Tayabas	2,400	85,255	245	8,205	96,105
Zambales	7,680	86,960	507	870	96,017
Zamboanga	...	161,688	...	...	161,688
Philippine Islands	146,586,391	9,503,010	2,416,526	751,190	159,257,117

TABLE XX.—*Coconut statistics, year ending June 30, 1920*

Rank.	Provinces.	Trees planted.	Trees bearing.	Nuts gathered.	Nuts consumed for food.
		Number.	*Number.*	*Number.*	
42	Abra	5,236	2,112	41,199	16,233
21	Agusan	685,179	296,665	9,679,299	77,033
8	Albay	4,305,742	3,256,746	54,659,912	15,370,371
26	Antique	495,099	224,125	2,612,405	276,974
36	Bataan	28,526	11,690	187,549	121,522
40	Batanes	23,695	15,441	54,696	39,195
42	Batangas	1,042,767	193,750	5,677,285	2,408,045
9	Bohol	2,496,201	1,403,789	41,633,833	880,077
38	Bukidnon	19,297	10,275	101,900	1,900
45	Bulacan	21,684	2,613	14,509	14,459
29	Cagayan	105,280	66,334	1,477,024	1,103,475
18	Camarines Norte	1,477,474	900,010	16,936,209	350,091
16	Camarines Sur	2,587,856	1,646,198	20,299,647	1,453,588
11	Capiz	1,976,871	947,501	29,126,232	902,473
31	Cavite	208,865	72,206	1,134,215	883,031
5	Cebu	5,665,469	2,932,277	127,825,684	2,946,315
33	Cotabato	112,276	38,287	979,295	172,685
25	Davao	820,163	186,902	3,376,762	287,800
35	Ilocos Norte	54,345	15,834	223,526	164,839
30	Ilocos Sur	121,493	81,754	1,397,577	651,637
20	Iloilo	1,437,055	671,532	10,365,613	1,543,687
43	Isabela	6,945	4,028	28,552	27,552
2	Laguna	8,605,623	5,806,854	255,304,538	3,404,928
32	Lanao	177,742	38,990	1,051,150	234,700
28	La Union	190,296	129,166	1,815,386	536,174
7	Leyte	2,982,830	1,717,928	72,011,930	7,551,230
12	Marinduque	2,033,484	1,349,663	25,804,310	951,017
23	Mindoro	821,490	354,865	5,096,443	423,577
3	Misamis	4,805,097	2,802,509	145,647,788	1,334,804
41	Mountain	16,960	13,140	53,588	44,422
39	Nueva Ecija	43,599	13,122	77,080	46,790
46	Nueva Vizcaya	3,698	1,578	12,227	4,650
14	Occidental Negros	1,231,760	732,444	22,007,049	4,116,033
10	Oriental Negros	2,071,982	1,112,026	32,598,494	1,904,934
24	Palawan	479,056	205,332	4,758,984	209,310
44	Pampanga	10,335	2,185	21,850	21,850
15	Pangasinan	1,474,811	816,366	20,469,535	2,499,520
47	Rizal	12,756	59	1,617	1,617
19	Romblon	1,737,349	587,420	10,901,703	284,264
4	Samar	4,510,906	3,159,362	131,468,134	5,283,320
13	Sorsogon	2,163,679	1,373,427	23,194,469	3,787,987
37	Sulu	33,484	13,000	129,300	129,300
17	Surigao	1,182,568	765,643	19,769,242	470,764
34	Tarlac	55,565	23,394	325,355	255,226
1	Tayabas	17,456,708	7,620,267	331,197,313	19,772,792
27	Zambales	250,039	144,462	2,333,943	757,918
6	Zamboanga	3,356,769	1,822,137	75,619,942	495,983
	Total	79,406,104	43,585,408	1,509,504,293	84,216,092

TABLE XX.—*Coconut statistics, year ending June 30, 1920*—Continued

Provinces.	Production of coconut products.			Average price per unit in the municipal markets.			
	Copra.	Oil.	Tuba.	Nut, per 100.	Copra, per 100 kilos.	Oil, per liter.	Tuba, per liter.
	Kilos.	*Liters.*	*Liters.*				
Abra	....	3,907	....	₱14.00	....	₱0.77	....
Agusan	2,393,254	647	34,100	6.00	₱25.82	.95	₱0.06
Albay	8,561,583	976,031	1,678,698	8.00	30.88	.63	.05
Antique	384,307	72,382	1,359,563	5.00	27.94	.72	.15
Bataan	2,340	5,668	....	15.00	23.85	.62	....
Batanes	443	1,240	....	3.00	7.90	.46	....
Batangas	782,213	1,305	....	7.00	31.18	.42	....
Bohol	9,542,907	142,748	4,502,082	7.00	30.02	.63	.09
Bukidnon	25,300	....	2,970	17.00	30.04	....	.10
Bulacan	....	5	....	19.00	....	1.00	....
Cagayan	....	37,186	....	9.00	....	.63	....
Camarines Norte	4,065,204	17,015	....	7.00	28.80	.42	....
Camarines Sur	4,378,544	152,973	917,881	9.00	27.40	.66	.07
Capiz	7,564,510	25,510	7,830,662	9.00	33.74	.60	.09
Cavite	50,727	2,562	....	9.00	31.73	.26	....
Cebu	28,835,802	139,508	43,919,079	7.00	31.12	.33	.17
Cotabato	166,031	2,245	141	8.00	25.14	.36	.50
Davao	785,881	1,629	86,587	6.00	24.28	1.91	.10
Ilocos Norte	....	6,881	....	16.00	....	1.45	....
Ilocos Sur	180,642	8,393	....	10.00	28.46	1.12	....
Iloilo	2,096,421	8,970	12,494,750	8.00	27.37	.94	.10
Isabela	....	83	....	22.00	....	1.25	....
Laguna	68,959,514	484,694	402,196	5.00	29.09	.61	.08
Lanao	198,605	3,882	148,800	11.00	33.01	.42	.07
La Union	307,838	15,654	....	7.00	25.89	.72	....
Leyte	15,000,686	165,206	8,323,757	5.00	27.23	.65	.10
Marinduque	6,376,802	2,188	1,156,282	3.00	26.95	.36	.09
Mindoro	1,116,173	962	260,510	6.00	27.70	.69	.09
Misamis	36,208,601	5,828	2,639,612	8.00	32.17	.42	.08
Mountain	....	1,066	....	7.00	....	.60	....
Nueva Ecija	....	3,800	....	14.00	....	.75	....
Nueva Vizcaya	....	1,029	....	20.00	....	.77	....
Occidental Negros	4,290,500	11,652	2,568,848	6.00	30.30	.58	.10
Oriental Negros	7,433,393	39,461	3,075,592	5.00	26.83	.30	.09
Palawan	1,091,252	2,739	274,182	5.00	30.27	.60	.09
Pampanga	....	....	....	12.00	....	....	....
Pangasinan	4,671,582	208,582	....	9.00	27.16	.73	....
Rizal	....	....	....	10.00	....	....	....
Romblon	2,968,196	1,156	872,520	5.00	27.80	.64	.08
Samar	34,673,966	168,886	2,613,581	6.00	26.42	.27	.14
Sorsogon	4,783,408	55,608	518,596	9.00	27.81	.54	.07
Sulu	....	....	10,184	10.00	....	....	.25
Surigao	5,061,644	26,339	1,364,911	5.00	29.14	.71	.09
Tarlac	....	6,948	....	11.00	....	1.11	....
Tayabas	75,311,079	34,598	384,645	4.00	30.24	.51	.12
Zambales	313,594	21,150	200	9.00	31.73	.56	.12
Zamboanga	23,022,431	11,136	627,914	6.00	33.06	.41	.12
Total	361,605,373	2,879,452	98,068,843	6.70	29.69	.59	.14

TABLE XX.—*Coconut statistics, year ending June 30, 1920*—Continued

Provinces.	Value of coconuts products.				Total value.
	Food.	Copra.	Oil.	Tuba.	
Abra	₱2,314	...	₱3,024	...	₱5,338
Agusan	4,373	₱617,888	1,024	₱2,046	625,331
Albay	1,467,209	2,643,630	602,853	81,767	4,795,459
Antique	14,769	107,366	52,335	217,035	391,505
Bataan	18,733	555	3,502	...	22,790
Batanes	1,117	35	571	...	1,723
Batangas	168,422	243,876	554	...	412,852
Bohol	58,162	2,865,045	89,824	409,401	3,422,432
Bukidnon	319	7,600	...	297	8,216
Bulacan	2,753	...	5	...	2,758
Cagayan	97,451	...	24,058	...	121,509
Camarines Norte	23,046	1,170,814	7,123	...	1,200,983
Camarines Sur	124,206	1,199,653	101,510	62,486	1,487,855
Capiz	81,390	2,551,951	15,350	736,789	3,385,480
Cavite	76,655	16,097	657	...	93,409
Cebu	208,528	8,973,007	45,625	7,448,711	16,675,871
Cotabato	13,314	41,745	799	71	55,929
Davao	18,200	190,774	2,889	8,832	220,695
Ilocos Norte	22,876	...	10,003	...	32,879
Ilocos Sur	62,010	51,408	9,421	...	122,839
Iloilo	109,943	573,868	8,409	1,391,227	2,083,447
Isabela	5,949	...	104	...	6,053
Laguna	173,437	20,053,638	295,718	33,681	20,556,474
Lanao	26,970	65,570	1,636	9,804	103,980
La Union	40,142	79,669	11,216	...	131,027
Leyte	408,506	4,084,320	107,801	826,626	5,427,253
Marinduque	29,238	1,695,384	795	105,237	1,830,654
Mindoro	26,942	309,190	661	24,151	360,944
Misamis	102,620	11,647,173	5,932	425,286	12,181,011
Mountain	3,259	...	637	...	3,896
Nueva Ecija	6,454	...	2,833	...	9,287
Nueva Vizcaya	917	...	794	...	1,711
Occidental Negros	258,235	1,299,915	6,711	263,555	1,828,416
Oriental Negros	94,511	1,994,558	11,912	262,917	2,363,898
Palawan	10,265	330,359	1,651	19,678	361,953
Pampanga	2,622	...	...	...	2,622
Pangasinan	193,308	1,269,228	152,442	...	1,614,978
Rizal	161	...	...	...	161
Romblon	14,090	825,224	740	74,685	914,739
Samar	340,349	9,160,235	45,802	362,748	9,909,134
Sorsogon	332,408	1,330,262	30,092	36,037	1,728,799
Sulu	11,715	...	...	2,546	14,261
Surigao	30,735	1,474,820	12,808	563,447	2,081,810
Tarlac	27,347	...	7,740	...	35,087
Tayabas	821,742	22,770,746	17,475	46,876	23,656,839
Zambales	67,207	99,505	11,760	24	178,496
Zamboanga	31,462	7,611,412	4,526	76,708	7,724,108
Total	5,636,381	107,356,520	1,711,322	13,492,668	128,196,891

TABLE XXI.—*Abacá statistics, year ending June 30, 1920*

Rank.	Provinces.	Area.		Production.	Average products per hectare.	Average price per kilo.	Total value.
		Cultivated.	Productive.				
		Hectares.	*Hectares.*	*Kilos.*	*Kilos.*	*Kilo.*	
....	Abra	......	......	......	......	......	......
11	Agusan	5,355	3,904	2,751,122	705	₱.038	₱1,035,342
2	Albay	94,940	64,962	31,599,004	486	.35	11,004,337
25	Antique	1,575	410	186,524	455	.49	92,370
....	Bataan	......	......	......	......	......	......
....	Batanes	......	......	......	......	......	......
26	Batangas	1,224	741	173,811	235	.57	98,574
23	Bohol	2,395	838	368,621	440	.28	103,367
9	Bukidnon	6,277	4,530	3,415,057	754	.22	762,410
....	Bulacan	......	......	......	......	......	......
....	Cagayan	......	......	......	......	......	......
10	Camarines Norte	19,529	14,456	3,219,931	223	.43	1,372,306
6	Camarines Sur	59,882	38,685	12,144,632	314	.32	3,895,604
19	Capiz	5,811	2,366	1,007,256	426	.45	451,067
12	Cavite	12,418	7,675	2,286,804	298	.64	1,406,905
16	Cebu	8,328	2,879	1,518,063	527	.52	796,692
28	Cotabato	109	42	29,348	699	.39	11,600
5	Davao	27,102	18,691	13,009,387	696	.40	5,206,213
....	Ilocos Norte	......	......	......	......	......	......
....	Ilocos Sur	......	......	......	......	......	......
21	Iloilo	2,798	1,698	739,898	436	.48	356,286
....	Isabela	......	......	......	......	......	......
18	Laguna	4,904	2,825	1,091,063	386	.62	678,598
27	Lanao	447	226	87,222	386	.32	28,213
....	La Union	......	......	......	......	......	......
1	Leyte	101,277	66,251	37,560,380	567	.35	13,202,521
17	Marinduque	3,388	2,818	1,100,866	391	.56	617,194
15	Mindoro	5,545	3,175	1,846,647	582	.42	768,450
8	Misamis	14,039	11,803	5,625,518	477	.39	2,205,286
....	Mountain	......	......	......	......	......	......
....	Nueva Ecija	......	......	......	......	......	......
....	Nueva Vizcaya	......	......	......	......	......	......
20	Occidental Negros	4,500	2,424	753,434	311	.57	430,446
14	Oriental Negros	13,176	3,464	1,853,162	535	.20	370,995
30	Palawan	18	3	1,455	485	.59	865
....	Pampanga	......	......	......	......	......	......
....	Pangasinan	......	......	......	......	......	......
....	Rizal	......	......	......	......	......	......
24	Romblon	2,133	1,219	283,360	232	.50	142,165
4	Samar	47,022	26,633	14,525,869	545	.45	6,533,890
3	Sorsogon	82,043	59,215	17,063,395	288	.49	8,394,137
29	Sulu	16	10	4,428	443	.39	1,750
7	Surigao	25,889	15,411	8,369,177	543	.28	2,392,234
....	Tarlac	......	......	......	......	......	......
22	Tayabas	1,932	1,136	418,146	368	.57	240,389
....	Zambales	......	......	......	......	......	......
13	Zamboanga	5,284	3,339	2,047,908	613	.22	458,641
	Philippine Islands	559,356	361,829	165,081,488	......	......	63,058,847
	Average	......	......	......	456	.38	......

TABLE XXII.—*Tobacco statistics, year ending June 30, 1920*

Rank.	Provinces.	Area cultivated.	Production.	Average products per hectare.	Average price per kilo.	Total value.
		Hectares.	*Kilos.*	*Kilos.*		
9	Abra	1,889	1,206,396	639	₱0.26	₱314,572
35	Agusan	21	11,730	559	.44	5,160
40	Albay	18	3,220	179	.33	1,028
21	Antique	244	95,588	392	.27	27,599
43	Bataan	1	460	460	.20	90
34	Batanes	51	14,260	280	.35	4,940
25	Batangas	254	62,146	245	.32	20,098
15	Bohol	1,121	279,220	249	.27	75,753
30	Bukidnon	39	20,700	531	.50	10,250
27	Bulacan	82	39,974	487	.37	14,835
3	Cagayan	14,198	10,609,716	747	.52	5,506,532
....	Camarines Norte	....	....	....	....	....
42	Camarines Sur	3	552	184	.22	120
20	Capiz	247	98,624	399	.38	36,976
38	Cavite	40	9,200	230	.35	3,200
5	Cebu	8,845	6,050,334	684	.23	1,401,738
....	Cotabato	....	....	....	....	....
37	Davao	83	9,522	115	.58	5,476
6	Ilocos Norte	6,556	3,339,416	509	.22	718,293
11	Ilocos Sur	1,868	973,590	521	.26	252,151
7	Iloilo	3,543	1,441,180	407	.37	527,135
1	Isabela	28,200	18,136,236	643	.65	11,397,447
....	Laguna	....	....	....	....	....
38	Lanao	82	27,738	338	.33	9,045
4	La Union	9,364	6,706,018	716	.28	1,852,415
16	Leyte	904	269,974	299	.35	92,878
41	Marinduque	8	2,254	282	.33	738
36	Mindoro	30	10,718	357	.50	5.360
24	Misamis	490	72,036	147	.55	39,910
23	Mountain	264	80,224	304	.27	21,611
8	Nueva Ecija	3,324	1,383,726	416	.35	481,852
18	Nueva Vizcaya	314	124,384	396	.63	77,791
12	Occidental Negros	3,070	853,162	278	.39	332,155
13	Oriental Negros	457	400,844	877	.26	105,675
32	Palawan	45	18,216	405	.61	11,098
33	Pampanga	80	14,720	184	.54	8,000
2	Pangasinan	12,656	10,732,122	848	.25	2,736,241
31	Rizal	54	18,354	340	.40	7,256
17	Romblon	283	172,914	611	.39	67,282
14	Samar	390	333,822	856	.32	106,182
22	Sorsogon	229	87,308	381	.33	28,438
....	Sulu	....	....	....	....	....
19	Surigao	249	116,012	466	.57	66,541
10	Tarlac	1,278	977,040	764	.37	358,189
26	Tayabas	100	59,110	591	.43	25,292
29	Zambales	100	25,622	256	.23	5,905
39	Zamboanga	49	5,152	105	.52	2,700
	Philippine Islands	101,123	64,893,534	....	....	26,765,947
	Average	....	....	642	.41	....

TABLE XXIII.—*Maguey statistics, year ending June 30, 1920*

Rank.	Provinces.	Area.		Production.	Average products per hectare.	Average price per kilo.	Total value.
		Cultivated.	Harvested.				
		Hectares.	*Hectares.*	*Kilos.*	*Kilos.*		
12	Abra	76	34	4,428	130	₱0.24	₱1,080
....	Agusan	....	....	....	....	....	....
15	Albay	3	2	632	316	.24	150
7	Antique	61	2	190	95	.19	36
....	Bataan	....	....	....	....	....	....
....	Batanes	....	....	....	....	....	....
....	Batangas	16	....	....	....	....	....
3	Bohol	2,996	2,344	1,406,806	600	.16	231,620
....	Bukidnon	....	....	....	....	....	....
....	Bulacan	....	....	....	....	....	....
11	Cagayan	55	17	20,177	1,187	.19	3,828
....	Camarines Norte	....	....	....	....	....	....
....	Camarines Sur	....	....	....	....	....	....
....	Capiz	45	....	....	....	....	....
....	Cavite	....	....	....	....	....	....
1	Cebu	14,847	9,679	10,167,627	1,050	.20	2,050,257
....	Cotabato	....	....	....	....	....	....
....	Davao	....	....	....	....	....	....
4	Ilocos Norte	4,023	1,799	1,095,174	609	.15	164,791
2	Ilocos Sur	5,022	4,503	4,616,111	1,025	.17	806,553
18	Iloilo	26	1	127	127	.31	40
....	Isabela	....	....	....	....	....	....
....	Laguna	....	....	....	....	....	....
....	Lanao	....	....	....	....	....	....
7	La Union	322	255	89,246	350	.19	17,287
8	Leyte	517	212	54,395	257	.17	9,333
....	Marinduque	4	....	....	....	....	....
....	Mindoro	....	....	....	....	....	....
....	Misamis	2	....	....	....	....	....
16	Mountain	34	3	253	84	.32	80
....	Nueva Ecija	1	....	....	....	....	....
....	Nueva Vizcaya	1	....	....	....	....	....
10	Occidental Negros	59	28	20,746	741	.16	3,424
6	Oriental Negros	454	303	134,406	444	.18	24,099
....	Palawan	2	....	....	....	....	....
....	Pampanga	4	....	....	....	....	....
5	Pangasinan	1,663	1,008	512,009	508	.17	86,976
....	Rizal	10	....	....	....	....	....
....	Romblon	6	....	....	....	....	....
....	Samar	2	....	....	....	....	....
13	Sorsogon	93	15	1,265	84	.22	280
....	Sulu	....	....	....	....	....	....
....	Surigao	2	....	....	....	....	....
14	Tarlac	8	2	759	379	.19	144
....	Tayabas	....	....	....	....	....	....
9	Zambales	168	77	53,699	697	.15	7,981
....	Zamboanga	45	....	....	....	....	....
	Philippine Islands	30,567	20,284	18,178,050	....	....	3,407,959
	Average	....	....	....	896	.19	....

TABLE XXIV.—*Carabaos, 1919*

Provinces.	Calves born during the year.	Deaths from disease.	Deaths from all other causes.	Slaughtered.	Number at the end of the year.	Average price per head.	Total value to December 31.
Abra	3,520	8	318	857	27,117	₱77	₱2,078,762
Agusan	177	7	20	21	2,654	119	316,160
Albay	3,465	357	703	858	26,074	100	2,608,250
Antique	2,137	92	177	209	29,167	141	4,103,380
Bataan	1,325	60	252	223	10,549	167	1,759,730
Batanes	1	....	....	....	4	150	600
Batangas	1,569	560	129	103	16,239	144	2,337,337
Bohol	6,915	1,402	327	1,222	55,210	103	5,696,085
Bukidnon	62	7	10	9	1,303	122	158,470
Bulacan	5,126	123	74	1,616	48,526	176	8,545,235
Cagayan	8,979	1,548	574	855	66,328	141	9,362,730
Camarines Norte	683	110	16	13	7,556	131	986,875
Camarines Sur	3,035	411	310	176	24,339	135	3,275,650
Capiz	5,194	127	224	711	39,277	170	6,687,770
Cavite	1,134	644	183	207	20,169	152	3,071,190
Cebu	5,764	411	509	1,216	60,618	124	7,529,977
Cotabato	16	1	1	3	1,053	96	101,104
Davao	497	34	71	31	4,664	97	452,050
Ilocos Norte	5,192	44	209	1,625	60,593	129	7,833,270
Ilocos Sur	3,976	13	173	1,923	44,652	120	5,347,224
Iloilo	6,472	866	523	1,521	70,366	213	14,953,755
Isabela	3,315	118	177	616	32,715	200	6,527,540
Laguna	3,352	133	409	1,390	24,319	201	4,900,114
Lanao	91	32	27	5	640	150	96,210
La Union	4,128	62	115	975	37,167	127	4,706,240
Leyte	4,885	728	226	599	46,904	148	6,942,170
Manila, city of	138	41	224	10	1,381	300	414,300
Marinduque	2,820	105	324	83	9,551	107	1,018,150
Mindoro	1,128	691	87	20	11,671	102	1,194,771
Misamis	1,615	264	225	340	16,992	154	2,616,610
Mountain	5,084	63	1,065	590	37,968	108	4,095,803
Nueva Ecija	5,480	474	447	983	67,787	176	12,914,600
Nueva Vizcaya	1,226	29	79	101	10,332	146	1,508,620
Occidental Negros	3,241	754	865	708	53,848	253	13,610,180
Oriental Negros	1,648	340	358	393	20,811	147	3,053,130
Palawan	606	47	61	7	7,151	80	574,430
Pampanga	2,575	294	255	789	49,167	188	9,226,545
Pangasinan	14,263	183	360	3,731	115,384	158	18,216,856
Rizal	2,139	206	529	320	20,313	167	3,383,260
Romblon	1,772	7	91	108	12,492	102	1,279,245
Samar	3,007	286	195	533	21,732	183	3,973,890
Sorsogon	3,889	180	220	121	26,495	105	2,776,440
Sulu	3	....	6	3	418	67	28,110
Surigao	3,558	274	145	896	28,836	90	2,596,155
Tarlac	3,325	234	302	1,144	45,613	167	7,637,180
Tayabas	5,913	2,339	188	1,057	37,358	121	4,523,285
Zambales	3,403	371	196	438	27,897	147	4,090,380
Zamboanga	1,611	150	129	238	6,844	118	809,385
Total for the Philippine Islands	150,012	15,230	12,108	29,597	1,388,244	....	209,919,203
Average	....	....	....	....	....	151	....

TABLE XXV.—*Cattle, 1919*

Provinces.	Calves born during the year.	Deaths from disease.	Deaths from all other causes.	Slaughtered.	Number at the end of the year.	Average price per head.	Total value to December 31.
Abra	4,077	1	188	360	12,510	₱117	₱1,466,816
Agusan	116	4	....	39	759	83	83,190
Albay	1,713	93	205	693	4,250	92	388,060
Antique	2,899	64	134	887	30,054	84	2,533,665
Bataan	248	....	8	109	1,067	87	93,300
Batanes	712	11	80	178	13,926	38	531,380
Batangas	10,883	2,471	1,476	5,540	82,275	126	10,383,886
Bohol	6,131	473	270	1,577	29,958	57	1,717,483
Bukidnon	296	....	11	21	5,680	88	502,650
Bulacan	872	6	9	746	3,727	117	435,675
Cagayan	1,970	167	125	474	5,046	99	498,134
Camarines Norte	346	24	23	379	1,576	115	181,025
Camarines Sur	818	29	41	299	4,438	101	447,665
Capiz	1,749	34	69	708	7,861	80	629,775
Cavite	1,697	517	177	1,656	12,363	110	1,360,145
Cebu	6,943	114	371	2,996	34,446	65	2,229,764
Cotabato	105	....	4	23	1,660	59	97,473
Davao	2,488	33	73	1,497	20,514	47	970,025
Ilocos Norte	3,403	12	63	1,029	17,449	113	1,979,140
Ilocos Sur	3,403	30	92	1,186	25,255	104	2,623,378
Iloilo	6,954	983	287	3,108	50,368	113	5,678,720
Isabela	821	40	62	296	4,944	128	631,118
Laguna	2,853	55	127	4,197	7,960	218	1,734,915
Lanao	325	7	42	73	1,431	89	127,948
La Union	1,342	15	42	651	8,418	92	771,692
Leyte	4,282	175	156	1,175	23,594	63	1,482,530
Manila, city of	....	3	66	22,656	1,669	230	383,870
Marinduque	7,543	25	2,921	889	17,698	52	926,895
Mindoro	4,563	3,084	318	719	21,328	57	1,223,145
Misamis	752	81	56	515	2,893	207	309,505
Mountain	6,748	4	1,345	937	32,665	110	3,459,702
Nueva Ecija	1,153	2	21	396	6,394	108	693,263
Nueva Vizcaya	698	17	77	182	3,743	145	542,415
Occidental Negros	2,314	372	190	1,618	23,891	139	3,316,221
Oriental Negros	1,727	33	206	785	14,813	74	1,099,973
Palawan	2,511	446	230	803	18,313	30	549,007
Pampanga	311	8	18	236	1,368	93	127,713
Pangasinan	5,712	35	179	1,698	18,676	132	2,472,544
Rizal	664	132	14	754	4,053	107	433,880
Romblon	3,478	1	275	857	15,607	43	677,535
Samar	4,508	75	107	986	5,801	97	564,635
Sorsogon	5,392	372	119	802	26,725	80	2,143,680
Sulu	30	....	6	559	322	70	22,540
Surigao	414	1	7	144	1,541	65	110,220
Tarlac	427	23	12	163	1,520	158	240,705
Tayabas	5,151	1,815	568	3,799	27,040	90	2,423,268
Zambales	1,958	109	64	432	12,134	166	2,019,840
Zamboanga	1,478	84	86	923	8,802	82	721,530
Total for the Philippine Islands	124,978	12,080	11,020	70,750	678,525	....	64,041,638
Average	....	....	....	....	....	94	....

TABLE XXVI.—*Horses and mules, 1919*

Provinces.	Colts born during the year.	Deaths from disease.	Deaths from all other causes.	Slaughtered.	Number at the end of the year.	Average price per head.	Total value to December 31.
Abra	1,668	....	109	8	7,733	₱137	₱1,060,533
Agusan	41	....	1	1	320	88	28,030
Albay	893	345	403	34	2,406	40	96,029
Antique	118	9	15	2	553	85	47,090
Bataan	56	1	22	21	390	134	52,440
Batanes	1	....	....	....	41	65	2,650
Batangas	4,845	47	212	36	36,779	112	4,131,340
Bohol	962	13	96	36	5,676	57	325,645
Bukidnon	70	3	11	....	1,915	92	175,445
Bulacan	867	19	40	311	5,945	149	884,095
Cagayan	1,617	131	144	3	7,467	135	1,009,210
Camarines Norte	10	....	5	....	60	87	5,205
Camarines Sur	62	49	47	....	356	116	41,285
Capiz	102	1	12	2	572	74	42,074
Cavite	1,869	173	358	134	16,067	125	2,004,389
Cebu	2,734	102	269	359	19,609	75	1,471,009
Cotabato	3	....	....	....	252	65	16,335
Davao	194	10	9	1	2,299	98	224,580
Ilocos Norte	2,014	12	234	121	13,945	122	1,707,290
Ilocos Sur	829	4	38	52	4,678	115	535,975
Iloilo	117	3	54	4	1,708	157	268,240
Isabela	757	48	90	387	6,214	189	1,173,235
Laguna	848	72	120	90	10,322	142	1,467,474
Lanao	54	1	11	....	232	143	33,225
La Union	594	10	18	7	2,974	119	355,030
Leyte	889	29	122	271	7,538	71	535,395
Manila, city of	....	60	406	....	8,106	275	2,229,150
Marinduque	1,368	25	119	....	4,983	63	315,590
Mindoro	474	164	60	....	3,118	69	214,085
Misamis	539	45	215	131	3,681	88	323,340
Mountain	1,368	3	227	54	6,306	74	465,869
Nueva Ecija	367	6	16	12	3,727	146	543,620
Nueva Vizcaya	479	4	19	8	1,028	161	165,740
Occidental Negros	252	35	45	10	2,847	115	327,425
Oriental Negros	1,054	11	341	87	9,931	70	696,690
Palawan	54	10	17	....	285	47	15,425
Pampanga	447	100	37	115	5,312	147	779,970
Pangasinan	3,404	139	145	26	10,578	115	1,216,541
Rizal	267	42	78	378	4,316	138	594,200
Romblon	1,413	20	96	....	2,834	50	142,015
Samar	239	13	90	1	1,325	90	119,855
Sorsogon	325	528	27	87	3,174	55	173,205
Sulu	2	....	1	....	87	80	6,960
Surigao	595	282	23	288	5,839	88	395,200
Tarlac	169	21	7	23	1,536	195	299,640
Tayabas	2,004	53	82	4	13,587	112	1,516,300
Zambales	958	52	96	12	4,022	152	612,375
Zamboanga	235	99	2,076	2	2,707	62	168,755
Total for the Philippine Islands	38,227	2,794	6,661	3,118	255,380	....	29,013,198
Average	....	....	....	....	....	114	....

TABLE XXVII.—*Hogs, 1919*

Provinces.	Farrowed during the year.	Deaths from disease.	Deaths from all other causes.	Slaughtered.	Number at the end of the year.	Average price per head.	Total value to December 31.
Abra	8,601	3,230	897	3,735	35,397	₱18	₱655,654
Agusan	8,154	613	220	1,043	13,214	26	338,478
Albay	13,485	5,227	759	9,630	73,149	21	1,554,424
Antique	5,455	284	400	10,154	60,609	18	1,067,423
Bataan	5,538	546	586	3,162	8,996	33	297,570
Batanes	438	4	15	187	3,476	5	18,691
Batangas	45,016	6,587	835	16,939	170,467	31	5,309,102
Bohol	23,828	6,632	1,265	13,909	138,576	23	3,230,019
Bukidnon	50	15	18	31	1,030	13	12,961
Bulacan	12,453	4,861	328	11,861	39,367	36	1,397,707
Cagayan	18,042	2,874	951	8,386	90,701	40	3,615,386
Camarines Norte	2,464	119	76	3,162	6,599	25	166,883
Camarines Sur	10,945	750	805	5,658	37,478	27	1,022,570
Capiz	14,332	1,259	746	8,213	53,161	18	975,110
Cavite	19,694	2,258	532	16,641	57,415	33	1,900,680
Cebu	96,111	11,097	2,381	88,580	379,043	30	11,507,365
Cotabato	72	....	1	94	308	21	6,588
Davao	2,378	169	170	625	21,708	41	894,480
Ilocos Norte	16,388	274	416	9,290	63,246	28	1,797,152
Ilocos Sur	22,964	762	872	15,764	61,237	29	1,780,891
Iloilo	24,881	1,600	1,334	19,051	124,302	15	1,867,620
Isabela	8,201	4,750	442	4,036	41,230	43	1,767,910
Laguna	13,312	1,224	504	15,070	28,189	35	998,315
Lanao	442	121	35	270	681	18	12,540
La Union	12,861	277	355	6,638	49,336	24	1,168,712
Leyte	24,849	2,569	2,465	12,183	101,510	23	2,369,376
Manila, city of	....	....	....	109,118	21,857	38	830,566
Marinduque	4,101	183	797	1,395	9,070	17	155,896
Mindoro	3,919	647	100	1,201	15,614	24	376,431
Misamis	9,805	1,906	687	7,858	52,205	28	1,454,030
Mountain	20,586	190	1,446	16,131	204,035	17	3,465,952
Nueva Ecija	17,124	2,382	1,268	12,915	143,380	38	5,458,128
Nueva Vizcaya	2,076	240	32	1,216	12,783	38	487,220
Occidental Negros	13,597	163	1,002	9,723	64,104	28	1,793,198
Oriental Negros	15,344	976	911	12,718	76,269	24	1,842,211
Palawan	15,108	527	415	1,392	34,946	9	312,514
Pampanga	20,784	10,480	1,048	15,200	78,867	36	2,802,475
Pangasinan	66,930	7,328	3,181	28,578	230,305	28	6,351,710
Rizal	17,540	484	1,347	15,743	33,469	23	781,273
Romblon	4,463	366	434	6,164	34,956	26	896,113
Samar	19,434	2,983	1,899	9,543	73,998	31	2,313,005
Sorsogon	11,307	4,778	465	6,720	36,121	23	829,380
Sulu	39	....	....	147	265	32	8,350
Surigao	12,924	1,266	256	5,541	56,813	29	1,624,720
Tarlac	17,126	1,348	536	8,369	177,726	21	3,730,560
Tayabas	13,531	1,923	511	9,964	56,383	29	1,659,463
Zambales	6,298	675	346	2,628	29,565	32	934,616
Zamboanga	8,875	372	311	3,108	26,620	16	430,276
Total for the Philippine Islands	711,865	97,319	35,400	569,684	3,129,676	....	84,267,694
Average	....	....	....	....	....	27	....

TABLE XXVIII.—*Goats, 1919*

Provinces.	Kids born during the year.	Deaths from disease.	Deaths from all other causes.	Slaughtered.	Number at the end of the year.	Average price per head.	Total value to December 31.
Abra	1 ,570	330	230	763	8 ,878	₱5.00	₱41 ,079
Agusan	2 ,067	....	51	20	6 ,080	10.00	60 ,351
Albay	5 ,274	365	418	3 ,056	21 ,879	5.00	109 ,693
Antique	1 ,549	94	182	772	15 ,302	3.00	47 ,798
Bataan	555	....	60	415	2 ,572	5.00	11 ,652
Batanes	241	....	15	127	1 ,818	4.00	6 ,798
Batangas	2 ,744	37	230	1 ,242	19 ,508	4.00	82 ,876
Bohol	4 ,084	83	580	1 ,398	25 ,185	4.00	105 ,578
Bukidnon	15	....	....	5	533	7.00	3 ,731
Bulacan	1 ,820	238	77	619	11 ,488	7.00	76 ,363
Cagayan	2 ,812	266	600	1 ,367	16 ,025	9.00	136 ,176
Camarines Norte	886	21	76	815	3 ,157	4.00	12 ,689
Camarines Sur	3 ,319	132	988	1 ,695	19 ,472	7.00	135 ,030
Capiz	6 ,336	105	741	2 ,555	37 ,697	4.00	165 ,512
Cavite	683	19	109	293	4 ,456	8.00	33 ,466
Cebu	9 ,872	3 ,126	758	9 ,026	55 ,624	5.00	282 ,294
Cotabato	53	....	4	14	416	5.00	1 ,996
Davao	167	....	....	9	1 ,211	9.00	10 ,845
Ilocos Norte	2 ,653	60	547	1 ,695	17 ,505	4.00	71 ,083
Ilocos Sur	4 ,263	4	427	3 ,001	23 ,744	5.00	112 ,898
Iloilo	7 ,568	458	963	4 ,590	44 ,728	5.00	203 ,504
Isabela	1 ,068	21	533	474	9 ,015	13.00	116 ,299
Laguna	1 ,371	67	189	449	5 ,001	6.00	28 ,014
Lanao	181	....	55	62	539	4.00	2 ,276
La Union	3 ,716	12	125	2 ,824	28 ,784	6.00	181 ,557
Leyte	6 ,933	215	686	2 ,958	37 ,604	7.00	258 ,943
Manila, city of	....	....	....	1 ,276	785	7.00	5 ,495
Marinduque	1 ,257	52	235	155	3 ,485	4.00	14 ,507
Mindoro	596	38	67	191	3 ,941	4.00	16 ,545
Misamis	2 ,343	246	368	868	11 ,397	9.00	104 ,553
Mountain	2 ,048	....	491	1 ,493	5 ,883	6.00	34 ,307
Nueva Ecija	3 ,415	21	275	1 ,927	18 ,844	8.00	143 ,443
Nueva Vizcaya	387	1	83	262	3 ,215	7.00	23 ,631
Occidental Negros	6 ,519	87	1 ,012	1 ,796	40 ,281	4.00	172 ,664
Oriental Negros	5 ,343	113	389	2 ,621	26 ,602	4.00	115 ,206
Palawan	116	40	65	69	456	4.00	1 ,878
Pampanga	3 ,892	172	752	2 ,359	27 ,281	7.00	180 ,123
Pangasinan	9 ,771	116	799	5 ,142	47 ,749	7.00	328 ,211
Rizal	933	15	86	461	4 ,277	6.00	27 ,585
Romblon	2 ,510	....	324	3 ,672	21 ,553	3.00	71 ,644
Samar	6 ,499	1 ,621	1 ,224	3 ,236	16 ,266	6.00	102 ,114
Sorsogon	4 ,414	1 ,127	375	1 ,612	21 ,369	4.00	79 ,352
Sulu	....	....	....	3	2	6.00	12
Surigao	1 ,673	10	198	746	7 ,979	4.00	33 ,633
Tarlac	4 ,549	87	416	2 ,242	31 ,222	6.00	187 ,542
Tayabas	2 ,154	74	251	849	8 ,923	6.00	50 ,896
Zambales	1 ,165	15	247	500	5 ,043	7.00	32 ,941
Zamboanga	620	26	97	104	7 ,075	7.00	48 ,030
Total for the Philippine Islands	132 ,004	9 ,514	16 ,399	71 ,828	731 ,849	....	4 ,072 ,813
Average	....	....	....	....	....	6.00	....

TABLE XXIX.—*Sheep, 1919*

Provinces.	Lambs born during the year.	Deaths from disease.	Deaths from all other causes.	Slaughtered.	Number at the end of the year.	Average price per head.	Total value to December 31.
Abra	677	39	82	249	2,586	₱4.00	₱10,060
Agusan	20	....	....	2	237	10.00	2,292
Albay	366	84	103	240	2,266	9.00	21,202
Antique	133	2	140	75	1,818	4.00	8,049
Bataan	84	4	34	47	198	9.00	1,750
Batanes	22	....	26	21	408	3.00	1,137
Batangas	31	12	4	21	223	10.00	2,274
Bohol	623	94	82	158	1,575	6.00	9,973
Bukidnon	....	....	....	....	200	9.00	1,822
Bulacan	254	37	2	176	1,079	8.00	8,685
Cagayan	1,017	76	238	540	6,591	9.00	58,015
Camarines Norte	9	....	....	4	69	11.00	785
Camarines Sur	894	12	76	188	3,073	10.00	30,065
Capiz	689	168	105	192	2,309	7.00	15,958
Cavite	56	5	35	31	312	9.00	2,669
Cebu	2,322	252	142	968	10,604	6.00	63,373
Cotabato	2	....	....	6	13	8.00	100
Davao	43	....	....	....	333	6.00	1,856
Ilocos Norte	2,189	95	386	1,168	10,685	5.00	51,350
Ilocos Sur	2,627	15	192	1,475	7,983	5.00	43,153
Iloilo	1,485	72	188	851	14,390	6.00	85,236
Isabela	531	19	13	334	3,543	12.00	43,713
Laguna	174	17	21	45	635	9.00	5,479
Lanao	1	....	....	....	4	5.00	20
La Union	1,011	65	78	583	5,678	8.00	44,131
Leyte	3,104	158	292	787	12,624	10.00	128,198
Manila, city of	....	....	....	80	331	11.00	3,641
Marinduque	....	....	....	....	16	9.00	148
Mindoro	69	....	15	3	279	14.00	4,000
Misamis	667	42	122	245	2,370	10.00	23,164
Mountain	821	....	141	480	2,771	7.00	18,065
Nueva Ecija	626	102	128	218	2,581	9.00	22,596
Nueva Vizcaya	48	....	3	27	150	8.00	1,240
Occidental Negros	4,066	170	457	1,346	27,671	5.00	159,282
Oriental Negros	1,603	35	143	446	7,460	11.00	84,736
Palawan	....	....	....	....	....	....	....
Pampanga	1,848	223	105	1,777	9,338	7.00	65,585
Pangasinan	2,791	84	97	1,143	9,140	10.00	87,869
Rizal	175	1	20	98	1,087	11.00	11,508
Romblon	39	....	....	4	291	9.00	2,675
Samar	680	30	40	196	1,513	12.00	17,638
Sorsogon	343	55	56	52	1,278	8.00	9,890
Sulu	....	....	....	....	12	10.00	120
Surigao	318	85	14	199	633	9.00	5,924
Tarlac	1,059	15	139	419	8,935	8.00	75,069
Tayabas	18	....	1	2	61	3.00	206
Zambales	599	53	86	1,105	2,304	6.00	14,284
Zamboanga	179	1	2	31	524	11.00	5,883
Total for the Philippine Islands	34,313	2,122	3,808	16,032	168,181	....	1,244,818
Average	....	....	....	....	....	7.00	....

ADDITIONAL DATA ON ADLAY[a]

By P. J. WESTER, *Agricultural Advisor*

Notes on Adlay (see this REVIEW, Vol. XIII, No. 3, 1920), was written about a year ago, before actual milling tests of the grain and baking tests of the flour had been made. Only small samples had then been hulled, by the native mortar and pestle method, and tried cooked like rice. The present paper is a progress report on the work with adlay and contains the information accumulated to date since the first article was written. See also *The Philippine Farmer,* Vol. VII, No. 3, p. 31, 1921.

With the arrival of the rains adlay was again planted at Lamao in 1920, and enough grain was harvested at the end of the year for a milling test made in February and March this year.

When the adlay arrived in Manila it was found that there were no flour mills, but Mr. E. E. Diot, manager of the warehouse and traffic department of the Pacific Commercial Company, Manila, finally undertook to try milling a sample. The first milling trial, in which flour was ground for the first bread-making test in the Philippines, is best described in the letter from Mr. Diot on another page of the REVIEW.

The first biscuits were made of equal parts of wheat and adlay flour, and they were tasted with no little curiosity. They were found to be such remarkably good eating that in the next lot the proportion of adlay flour was increased to two parts to one part wheat flour. These biscuits (Plate I) were darker in color than those made in the first trial but they were light, and of excellent eating quality.

A larger sample of the grain was then ground and an attempt was made to make biscuits solely of adlay flour. These were dark like rye bread, and the dough failed to rise. Therefore, in subsequent bakings the flour mixture was half and half wheat and adlay flour, and two-thirds adlay to one-third wheat, and biscuits were made and distributed to many people. A third lot of adlay was now ground by the Pacific Commercial Company, and biscuits were made and served, first at a tea given by the Philippine Chamber of Commerce, and then at luncheons given by the American Chamber of Commerce, and the Rotary Club, Manila, respectively. Altogether some 500 biscuits have been made and distributed for sampling.

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[a] Adlay should be pronounced ad'lay; silent a, and y as in "my" in the last syllable, with accent on the first syllable.

The reception of adlay as a breadstuff at the functions referred to and by various people who have sampled adlay foods is best reflected in the press clippings and letters reproduced in another part of the REVIEW.

With inadequate milling machinery no attempt was made to remove the seedcoat of the grain in the course of milling, and the flour therefore was dark, and the biscuits were of the color of Graham flour biscuits. They were light in texture and of excellent flavor and eating quality, and possessed a peculiar nutty, appetizing flavor, believed to be derived from the unusual amount of natural fat in the grain, which distinguished them and made them superior in tastiness to biscuits made of other flours.

Hot cakes made from a mixture of two-thirds adlay and one-third wheat flour were also light and of good flavor and superior to those made of buckwheat and wheat.

The whole grain makes a good rice substitute.

The cracked grain also has been tried out as a breakfast food. Thus prepared it swells rather more than oatmeal and wheat preparations. The opinions relative to the value of adlay as a breakfast food vary, some declaring it equal to popular cereal foods while others consider it inferior. Perhaps it is more nearly correct to say that it has a distinctive flavor, is different from other foods and so appeals less to some than to other appetites.

Altogether, it has been demonstrated beyond a doubt that adlay is a palatable and wholesome food for the table, and there is every reason to believe that with a proper mixture of wheat flour it can be used for all purposes for which wheat flour is used.

With a view to ascertain the food value of the different kinds, and possibly discover a variety more adapted to bread making than others, grain of several adlay varieties has been submitted for analysis to Dr. H. A. Wells, chief, division of chemistry, and Mr. F. Agcaoili, chief, section of food analysis, Bureau of Science, to whom the writer is indebted for the following table:

TABLE I.—*Analyses of adlay*

Sample.	Weight of 100 grains.	Waste.	Hulled grain.	Hulled grain.					
				Moisture.	Protein Nx6.25.	Fat.	Ash.	Crude fiber.	Starch, carbohydrates.
	Grams.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
A. Bukidnon	8.43	30.08	69.92	9.27	11.76	5.02	1.00	0.87	72.08
B. Mountain Province	23.25	47.76	52.24	7.64	17.32	7.23	1.41	1.02	56.38
C. Lanao	10.38	23.40	76.60	10.27	11.41	6.56	1.72	0.90	67.14
D. Mountain Province	19.89	42.86	57.14	11.29	10.94	5.42	1.75	0.83	69.77
E. Mountain Province	11.90	38.57	61.43	10.48	10.72	5.93	1.88	0.83	70.16
F. Cotabato	8.11	28.57	71.43	10.53	13.34	5.36	1.61	0.68	68.48
G. Cotabato	8.23	33.52	66.48	10.95	11.38	3.80	1.42	0.58	71.87
H. Cotabato	7.83	38.80	61.20	9.64	12.56	4.15	1.37	0.78	71.50

All these samples were grown at the Lamao Experiment Station, from seed obtained from the provinces named, excepting C which was grown in Lanao from seed obtained in Bukidnon, and E which was obtained direct from the Mountain Province.

The samples A and C represent the grain used in the bread making tests.

While these analyses have shown a rather remarkable variation, especially in the fat and protein content, none of the samples have indicated a moist gluten content, and so the flour cannot be used for bread making without an admixture of wheat flour. Adlay "straight" might make a very good cracker or hard tack. Mixed with wheat it would certainly do so.

All the adlay samples have been richer in fat than wheat, one contained more than four times as much, and 4 other samples were more than three times as rich in fat as wheat.

The protein content of adlay approximates that of wheat. Somewhat poorer in protein than wheat in some samples, three kinds show a higher protein content than wheat; one variety containing about 4 per cent more protein than wheat. The carbohydrate and starch content is about the same in adlay and wheat.

Attention is called to the great difference in waste in the hulling of the grain, which, with 47.76, 42.86, and 38.57 per cent, respectively, is greatest in the large grained sorts from the Mountain Province grown at high elevations. The waste is the least in the small grained strains from Mindanao, in one analyzing as low as 23.40 per cent. Since the hull in the small grained sorts is thinner and more easily broken, and the yield of grain apparently considerably greater than in the large grained forms, the small grained types seem to be the most promising for general culture.

In the *Notes on Adlay* the analysis of several staple grains and pulses were given for comparison with adlay. In order better to show the status of adlay as a food and in relation to other staple grains, the nutrient value and nutrient ratio of the adlay analysis exhibited on the preceding table, together with those of wheat, corn, rice, and oats is shown below:

TABLE II.—*The nutrient ratio and nutrient value of adlay and other grains.*

Samples.	Nutrient ratio.	Nutrient value.
Adlay A	1:7	105.0
Adlay B	1:4.6	98.9
Adlay C	1:7.1	93.3
Adlay D	1:7.4	92.9
Adlay E	1:7.7	94.2
Adlay F	1:6	93.8
Adlay G	1:7	91.8
Adlay H	1:6.4	93.4
Wheat	1:6	87.4
Corn	1:8.2	91.2
Rice	1:10	88.3
Oats	1:5.6	80.6

As indicated above adlay exceeds in food value the four grains in question: wheat, rice, corn, and oats.

If we accept 1:5 as the dietical standard ratio of proteins to carbohydrates and fat, it would appear that adlay closely approximates wheat as an ideal food and that it is a far better balanced food than either rice and corn, the two principal grains in the Philippines at the present time.

It may be well to state that digestibility tests other than those made by Dr. A. M. Saleeby, referred to on another page in the REVIEW, have not yet been made. However, it seems reasonable to believe that adlay equals corn in this respect to which grain it is most closely related.

In view of the foregoing data it would appear that a mixture of equal parts of adlay and wheat flour, or two-thirds adlay and one-third wheat, for all practical purposes would be equivalent to an equal quantity of wheat flour, except that it is a trifle richer in fat. Since the baking trials have shown conclusively that the biscuits made of this flour mixture are equally as attractive to the eye as those made of wheat flour, and that they are actually superior in eating quality, the addition of adlay is a distinct advantage. In other words, we are faced by the rather unusual fact that the proposed substitute is superior to the original.

Many people have expressed incredulity relative to the cereal value of adlay, contending that if it had the merits claimed they would have become discovered long ago and the grain would have become widely grown and used as a foodstuff before now.

However, the previous rejection of adlay as a staple food apparently has been due not to an intrinsic inferiority of the grain, but to the peculiar features which have made it inferior to rice as grown by a primitive people—objections which are removed by the advent of modern machinery and a better knowledge of the grain. Of course, the long growing season is admittedly a drawback, though to some extent this is compensated for by the fact that adlay is less subject to attacks of locusts than rice and corn. The *maya* or rice bird, and the wild pigeon, frequently so destructive to rice, do not feed on adlay, so far as known. This is also true of the rice bug, *Leptocorisa acuta,* one of the two most destructive insect pests of the rice plant.

Like rice, adlay originated in tropical Asia. But rice possessed the great advantage in being the better keeper of the two, which, outside of its food value, has probably been the most potent factor in making it the most important of all the tropical grains.

Then, rice is far better adapted to preparation for food by the mortar and pestle—the original grain mill invented by man—method of hulling the grain than adlay; first, because when the pestle is brought down on the smooth, round adlay grains, these fly out of the mortar in all directions, whereas rice does not; second, because the kernel of adlay is softer than that of rice and is more easily broken in the course of hulling, resulting in more waste than in hulling rice, which is hard and flinty. With the introduction of modern machinery these disadvantages disappear.

Finally, a good bread could not be made without an admixture of wheat flour which was not to be had in the tropics until within comparatively recent times. To be sure, as has been said in my previous paper on adlay, that veteran in Anglo-Indian agriculture, Watt, many years ago suggested the possibilities of adlay as a breadstuff, but apparently no one in India has carried out field experiments and milling and baking tests to ascertain on the one hand the value of the grain to the farmer, and on the other its possibilities as a foodstuff to the consumer.

Because of the interest in adlay evidenced here an attempt has been made to trace what has been and is being done with adlay in the Dutch East Indies, apparently the only country outside the Philippine Islands where attention has been paid to it by scientists within recent years.

A dispassionate account of both the soft-hulled and wild forms is found in *Nuttige Indische Planten,* by M. Greshoff; 1894, quoting analyses of the grain made in India.

Van Gorkom's *Oost Indische Cultures,* 1918, does not mention adlay.

Teysmannia, Vol. XXIX, 1918, pp. 59, 60, contains a brief article by P. W. Broek, stating that the flour mixed half and half with wheat flour is excellent for making bread, good for pancakes and for porridge. Commenting hereon W. G. Borsma says that in 1912 about 1,000 piculs of adlay grain was shipped from Palembang, Sumatra, and sold at fl. 6 to fl. 7 per picul. (1 picul=62.5 kilos; fl. 1.00 = ₱0.80). He concludes by saying that: "Opinions vary as to the value of adlay as a foodstuff. That adlay is a nourishing grain is certain. However, there are doubts as to whether because of the big hull it is sufficiently profitable to deserve preference over other crops."

Later in the year the same publication, p. 455, contains another account on adlay, where the writer, K. v. d. Veer, closes his article by quoting Greshoff: "In Burma it is said that after the world was created the rats brought rice and adlay from the mountains to the plains below. Then, when the people arrived they choose the rice for themselves and allowed the rats to keep the adlay. He concludes:

"I believe that it is advisable to trust in the wisdom of the ancients."

Circular No. 20, Djali Bras, by L. Koch, dated July, 1919, contains an account of trials made with adlay—in Java known as *Djali Bras*—at Fort de Kock, Sumatra, at an elevation of 925 meters, and in Buitenzorg, Java, where the yields obtained were 3,528 and 2,867 kilos per hectare, respectively. At Fort de Kock the adlay was planted 3 seeds to the hill, the hills 50 centimeters apart, in rows 75 centimeters apart. In Buitenzorg 4 to 5 seeds per hill, the hills 60 centimeters apart, in rows 90 centimeters apart.

The waste in hulling the grain was found to be 30 per cent of the weight in Sumatra, and 47.5 per cent in the Buitenzorg trials.

The hulled grain was tried as a rice substitute, for which it is recommended, and the author quotes from the aforementioned article by Broek that adlay flour mixed with an equal quantity of wheat flour can be used in making bread.

The analyses made of the adlay in Buitenzorg are as follows:

	Per cent.
Moisture	14.00
Protein	11.25
Fat	2.22
Carbohydrates	70.40
Crude fiber	1.55
Ash	0.55

As supplementing the cultural directions in the *Notes on Adlay,* it may be mentioned that if the grain is sown as there recommended, 4 to 5 seeds in the hill, the hills 40 to 60 centimeters apart, in rows 70 to 80 centimeters apart, an average of 10 to 15 kilos of good, clean seed of the small grained sorts is required to plant one hectare. The larger the grain the more seed is needed, of course, the variety with the largest grains requiring up to 40 kilos of seed grain to the hectare.

In view of the wide difference in the figures obtained in the two yield trials made in the Philippines in 1918 and 1919—3,625 and 1,634 kilos, respectively—and accidents to the adlay planted at Lamao in 1920 which prevented us from getting reliable yield figures for comparison, it is fortunate that the Dutch have also experimented with adlay, so that their data may be compared with our own. As already noted adlay yielded at the rate of 3,528 and 2,867 kilos of grain respectively in two trials made in Sumatra and Java. The data on hand therefore would indicate that with good culture a crop of 2,500 to 3,000 kilos per hectare may be counted on, and there should be no difficulty whatever in getting a crop of 2,000 kilos of grain to the hectare. This compares very favorably with Philippine upland rice with an everage crop of 750 kilos per hectare and a maximum of 1,750 kilos; lowland rice an average crop of 900 to 1,300 kilos with a maximum of 2,000 kilos, and corn with an average crop of 900 kilos per hectare. Nor is it without interest to know that a yield of 18 bushels of wheat per acre amounts to only 1,225 kilos of grain to the hectare.

It is also worth noting that the crop figures for adlay have been obtained from unimproved sorts. Who can tell what yields may be attained when the grain shall have been the object of systematic breeding work as have other cereals?

In storage, adlay has recently been found to be attacked by a small moth, which was sent for identification to Dr. C. F. Baker, Dean, College of Agriculture, University of the Philippines, who writes:

> The little moths you send are *Sitotroga cerealella,* an abundant stored grain pest found all over the world. It attacks a great variety of products. I imagine that adlay, in spite of its hard shell, will be subject to attack, in storage, of a number of the usual stored grain pests. This will be especially probable in the case of some of the beetles which can bore through very hard substances.

One of the rice weevils, *Sitophilus oryza* L., is also known to attack adlay, but data as to its destructiveness are lacking.

One variety from the Mountain Province has been reported to mature in 90 days, but ordinarily adlay has a growing period of from 5 to over 6 months, and requires a reasonable amount of rainfall throughout rather more than 4 to over 5 months in order to produce a good crop. On the other hand, unless they are accompanied by a strong wind, the heavy rains that fall from August to October in central Luzon apparently do not injure the plant.

It follows that in the Philippines adlay may be grown practically wherever the land is adapted to it. The grain grows well on volcanic, sandy, to permeable loamy soils. Heavy, sticky lands are not recommended for adlay until further information shall have been obtained as to its behavior on such soils.

Thus, it could be grown, for instance, on the volcanic and loamy soils in Cavite, Batangas, and Laguna, now devoted to upland rice, corn, and sugar cane, in the northern part of Nueva Ecija, Nueva Vizcaya, and in the Cagayan Valley, in eastern and northern Negros, and in Bukidnon.

In view of the fact that an admixture of wheat is required in using adlay flour, it is interesting to recall that the Spaniards cultivated wheat in the Philippines, especially in Batangas, in the hilly country from about Tanauan over Lipa to San Jose. Wheat is still grown to a very limited extent in the Cagayan Valley, northern Luzon.

In Bukidnon, Mindanao, on the table lands ranging from 500 to 1,000 meters above sea level, is perhaps the largest single area in the Philippines where wheat might be grown successfully. Since water power is plentiful, and adlay is abundantly productive in the same region, if wheat on trial is found to pay, the two grains could be cheaply milled locally, and the flour put up in suitable mixtures for shipment to the other parts of the Philippines. If this theory works out in practice, as apparently it should, Bukidnon, as a source of breadstuff, will become one of the most important agricultural sections in the Philippine Archipelago.

Harvested like rice by the native population, as far as the climate is concerned, adlay can of course be grown wherever rice is cultivated. But the great advantage of adlay over rice is, that more productive than rice, where the growing, wet season is followed by a dry period, it should be possible to grow and harvest adlay with machinery like wheat, which cannot be done with rice grown in paddies, abolishing the hardest and most disagreeable work of farming, the preparation of rice paddies and transplanting rice. It would appear then, that with lowered production cost and a larger yield of a better grain per unit area, adlay is destined to supplant rice as the leading staple grain not only in the Philippines, but possibly throughout a very large part of the tropics.

WHAT OTHERS SAY ABOUT ADLAY

The first news about the findings of this Bureau relative to adlay was given to a local paper March 9, 1921, since when the new grain has been the subjects of considerable discussion in the Manila papers. Extracts from the original news story about the adlay, some of the press comments and new items, and letters received from several people who were among the first to eat adlay in the Philippines are published herewith in the belief that they will be of general interest to our readers in foreign lands, and assist in attracting attention to a grain which apparently deserves widespread attention in the tropics, and quite probably in the warmer regions of the temperate zone where the rainfall is sufficiently abundant to permit its profitable cultivation.

News Item, the *Manila Times*, March 9, 1921.

"ADLAY"—A NEW STAFF OF LIFE

A DISCOVERY THAT MAY SOLVE THE PHILIPPINE FOOD PROBLEM

If you were told that there is a half wild cereal in the Philippines which is twice as productive as rice grown under equal conditions, and more easily hulled: that is, more nutritious and at least as palatable as rice, if not more so; that it can be prepared and eaten as rice and in addition ground into flour and used, mixed with wheat flour, in making bread and biscuits and an equivalent to the famous corn bread of the South; that it makes an excellent breakfast food, and that an appetizing hot cake to top off the morning meal can be made from it, and yet that so little of this grain is grown that if some one offered to pay its weight in gold, one ton of it could probably not be scrapped together in all the Philippines, you wouldn't believe it, would you? It sounds impossible, like a fairy tale, and yet we are assured that it is so by those who profess to know. If these claims are substantiated, the world will have gained a new cereal the discovery of which many effect a change in the food habits of millions of people.

* * * * * * *

Last week a sample of adlay was hulled and ground into meal and "cracked adlay" by the Pacific Commercial Company, and cooking tests have since been made in making bread, biscuits, and hot cakes of the meal, and in preparing the cracked grain for a breakfast cereal. It was found that bread cannot be made from adlay flour alone, but in all other tests the new grain came through with flying colors. We understand that analyses are now being made at the Bureau of Science of several adlay varieties found in Mindanao and the Mountain Province in the hope that some may be found suitable for bread making.

Mr. Wester says: "When I saw that it analyzed about like wheat, and later obtained the high yield figures, it occurred to me that if it possessed bread-making qualities, here was an important grain for the tropics, though it seemed incredible that the possibilities of a grain known before the Christian era begun had been overlooked, especially by the several writers and botanists who have described it from time to time since the 17th century. * * * considering that adlay far surpasses rice in yield, that it is a more nourishing and a better balanced food that it can be eaten like rice and besides can be used as a very acceptable wheat flour substitute for biscuits and hot cakes, and that the grits as a breakfast cereal are equal in palatability to those from any other grain, and that it can be grown from sea-level to an elevation of more than 1,000 meters, it is fair to assume that it is only a question of time when adlay will be widely cultivated in the tropics.

"The value of adlays as a wheat substitute becomes more manifest when we consider the annually increasing wheat flour importations by tropical countries. We hear much about the annual importations of rice, and every so often the farmer is exhorted by the newspapers to grow sufficient rice to meet the domestic demand therefor. The rapidly growing flour imports seems to have been forgotten. It may come as a surprise to many to know that in 1919 our wheat flour imports were about nine million pesos, or somewhat greater than the rice imports. The Filipino is apparently changing his food habits and using more and more bread. In view of the increasing flour imports it would therefore appear that a wheat substitute that can be grown in the Philippine Islands is worthy of more than passing attention. Then, adlay makes a good food grain for cattle, horses, and poultry, which annually consume large quantities of rice. With a greater production per unit area than rice it will pay the farmer to grow adlay as a feed for his domestic animals if nothing else and thus realease large quantities of rice for human consumption."

What adlay is? If you have traveled in the provinces you have probably seen necklaces on children made of gray, whitish or brown, hard, shiny beads. And if you are from Europe or America and old enough—you may remember certain small boxes with their lids covered with small shells with little round things about as big as marrowfat peas interspersed. They are also made into portieres in the Philippines. These are the seeds or grains of the original wild species of adlay. The variety from which flour has been made has a soft, thin hull which is easily separated from the kernel. * * *

Editorial, the *Manila Times,* March 14, 1921

ADLAY BISCUITS

We tasted an adlay biscuit this morning. Adlay biscuits look like those appetizing biscuits pictured in the advertising section of the *Ladies' Home Journal.* They are golden brown, crisp, and have a fine nutty flavor, tasting something like biscuits made of a mixture of corn and oatmeal. We would eat half a dozen for breakfast every morning if we could get them. But adlay grain and flour, let alone adlay biscuits and bread, are not yet on the market. The importance of adlay, although cultivated for centuries in various Oriental countries, has not been realized by western agriculturists until very recently. * * * For some strange reason the cereal seems to have been overlooked as the great staple grain crop of the tropics.

Adlay is a grain growing something like sorghum and does not need irrigation. It may be grown under upland rice conditions. It is threshed and milled as easily as rice. It may be eaten either cooked as rice is, or used for making bread. It analyzes very much like wheat, and is richer in protein and fat than rice.

Last year we imported more wheat than rice. Most bread crops will not grow well in the tropics. Adlay, on the other hand, is a tropical grain, and yields twice the amount with the same amount of labor as other grain crops cultivated here. The cultivation of adlay in the Philippines would make us independent of both rice and wheat imports.

The Dutch are already taking an interest in the cultivation of adlay in Java and Sumatra. We ought to be able to beat them to it in the Philippines if we take hold of the proposition in the right manner.

No other organization could help so much in this matter as the Bureau of Education. The success of this bureau's corn campaign is well-known. The cultivation of adlay could be taken up in the agricultural schools and in the settlement farm schools, and the girls in the domestic science classes might be taught ways of preparing it.

Several commercial companies in Manila are watching developments with interest.

The cultivation of adlay is not an experiment. It is grown in many parts of Asia and by several groups of "wild" people in the Philippines. The grain has been analyzed by chemists. It has been grown at experiment stations. Flour has been made out of it. Biscuits have been baked with it. We have eaten the biscuits, and are willing to eat more of them at any time.

Editorial, the *Manila Times,* March 16, 1921

AFTER TWENTY THOUSAND YEARS

In discussing adlay, the new grain, a scientist the other day was inclined to the opinion that there must be some reason, although apparently unknown, why the grain is not used more extensively, it having been known for centuries throughout a great part of tropical Asia.

However, another gentleman, equally learned, expressed the opinion very decisively that such an *a priori* assumption was not warranted. He said that all the grains at present in general use were used by Neolithic men (the men of the New Stone Age) twenty thousand years ago, and that no new grain has been extensively adopted by mankind since that time.

Men in the mass are greatly disinclined to adopt a new food. The rice-terrace people in the mountains of central Luzon, for instance, will not eat upland rice except perhaps in times of scarcity. The Japanese dislike eating rice grown in the Philippines. Among Americans in the Philippines newcomers will look with some suspicion upon the old-timer who admits that he likes rice. Local varieties of a grain are often developed, and men will look with feelings of mingled pity and contempt on people eating perhaps the same grain but of somewhat different flavor.

Mr. Wester himself advanced a number of possible objections to adlay which might account for the fact that it has not been widely adopted. He said that adlay grain is so round and smooth that when an attempt is made to hull it with the ordinary mortar and pestle it flies out of the mortar in all directions. The grain is also rather soft so that it is likely to be broken up under the pestle.

The *Manila Times* is frankly interested in adlay. It would be a wonderful thing if after twenty thousand years a new grain had been found suitable for general cultivation and widespread use. It would make the Philippines self-supporting so far as breadstuffs are concerned. Experiments carried on here with the new grain would attract the attention of the world. It is up to the Bureaus of Agriculture, Science, and Education.

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News Item, *Philippines Free Press,* March 26, 1921

"Adlay bread," made from the tropical grain the use of which Mr. Wester, of the Bureau of Agriculture is trying generally to encourage, and tea were served to the members of the Philippine Chamber of Commerce on board the cutter *Corregidor* at a reception last Wednesday, given by the Bureau of Agriculture in honor of the members of the chamber who were leaving on a trip to the southern islands. The guests expressed themselves well pleased with the bread, and surprised to find it so excellent.

Editorial, the *Manila Times,* March 21, 1921

AN HISTORICAL EVENT

The members of the American Chamber of Commerce were gathered together yesterday for luncheon on a very momentous occasion. They ate, they all ate adlay biscuits. More than ten dozens of them were served, and all of them had disappeared by the end of the luncheon. Those that were not eaten were surreptitiously slipped into pockets.

This was undoubtedly the first time in history so many biscuits of this new cereal were ever baked; and the Americans present constituted a larger group of men than any that had ever eaten such biscuits before.

The foregoing may read like humor to some, but it is plain and unadorned fact. It may read like silly exaggeration to some to call the eating of very ordinary biscuits and historical event, but again it is a plain and unadorned fact.

As we said some time ago, no new grain has been generally adopted by mankind for more than twenty thousand years. All our present cereals were known to men of the New Stone Age, who used stone hatchets, lived in caves, and dressed in the skins of beasts. This is partly explained by the fact that the number of cereal plants fit for human consumption is limited, and partly because of human conservatism in the matter of adopting new foods.

That adlay is a palatable breadstuff has been absolutely proved. If it should prove fit for general cultivation and wide consumption, if it should prove the third of great tropical grains, then the significance of yesterday's luncheon in the dining room of the American Chamber of Commerce will burst upon an amazed and grateful world.

Editorial Note, *Progressive Agriculture,* May, 1921

We have eaten biscuits made of adlay flour and have found them of remarkably good quality. The field experiments made by the Bureau of Agriculture have shown the adlay to be very productive and that the grain can be grown over a very large part of the Philippines. Analyses made by the Bureau of Science show the grain to be wholesome and nutritious, in fact a better balanced food than rice. We have been told that adlay is grown here and there in the provinces, but very little is known about it and how it is used. We wish to know more about it for the benefit of our readers and invite everybody to write us all they know about adlay, giving the local variety names of adlay, the time of the year when it is planted, how it is cultivated, when it is harvested, how it is stored and how it is prepared and eaten for human food, and to what extent it is used for animal food.

News Item, *The American Chamber of Commerce Journal*, June, 1921.

A NEW GRAIN FOR THE PHILIPPINES

The grain experts of the Bureau of Agriculture have been experimenting for some time with a grain known as adlay which, when growing, looks like a tall coarse grass. In India, it has been used for hundreds of years by some of the hill tribes as a grain and a food. Only recently has it been tried out as a food in the Philippines.

The milled grain analyzes practically the same as wheat, except that it contains nearly four times the amount of fat. Adlay makes a delicious hot cake and is very palatable for use like pearl barley in soups. "Cracked," the grain makes a capital breakfast food, and the whole kernel boiled makes a good rice substitute.

Adlay is a more nourishing and better balanced food than rice. Because it far surpasses rice in yield per hectare and can be grown without irrigation over the greater part of the Philippines, it will undoubtedly become an important crop, after it becomes better known.

The principal objection to adlay is that it is hard to hull by the primitive mortar and pestle method, and because the kernel is much softer than the rice kernel, it is easily broken, resulting in considerable waste. However, with a little experimenting, modern machinery unquestionably can be designed to hull adlay successfully.

Food habits are very strong and not easily changed. The present problem in making adlay one of the staple foods of the Philippines will therefore be in the education of the people to a recognition of the superiority of adlay over rice.

PACIFIC COMMERCIAL COMPANY
MANILA
PHILIPPINE ISLANDS

February 21st, 1921.

DEAR SIR: I hand you herewith the sample of flour obtained from the species of grain which you stated came from Mindanao that you said you would like to have hulled and milled for experimental purposes in trying to convert same into a substitute for wheat flour. The hulling was very easily performed. When it came to the milling, however, I regret to say that we did not meet with such success, owing to the fact that we have no suitable grinding machine. After washing the hulled grain, we ground some as fine as we possibly could in the sugar pulverizing machine, then sifted the flour through a fine mesh cloth.

I took the liberty to take home the grits or such of the flour as did not go through the cloth during sifting, and this I had the cook prepare into a breakfast food in the same manner as cracked wheat or meal is prepared. It made a very acceptable substitute for Scotch oatmeal. I also appropriated a small quantity of the flour and had the cook make four small biscuits from same. These biscuits were fairly light and of very good savor and could easily pass for Graham flour biscuits.

I think it is well worth while for you to carry on experiments on a larger scale with this cereal; there is no doubt in my mind that if it can be grown in commercial quantities, it can be converted into a valuable article of food.

Yours very truly,
PACIFIC COMMERCIAL COMPANY, WAREHOUSE
AND TRAFFIC DEPARTMENT,
By (Sgd.) E. E. DIOT,
Manager.

THE GOVERNMENT OF THE PHILIPPINE ISLANDS
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES
BUREAU OF AGRICULTURE

MANILA, *March 8, 1921.*

DEAR MR. WESTER: Having watched the progress of the adlay in the field experiments with much interest I sampled the biscuits you furnished the other day with considerable curiosity, and I confess that their excellence far surpassed my expectations. Apparently we have in adlay a grain of hitherto unsuspected merit.

In view of the increasing wheat flour imports a good substitute therefor which can be grown in the Philippines would be of great value, especially if it is found that it can be cultivated and harvested by machinery.

Sincerely yours,
(Sgd.) ADN. HERNANDEZ,
Director of Agriculture.

THE GOVERNMENT OF THE PHILIPPINE ISLANDS
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES
BUREAU OF AGRICULTURE

MANILA, *March 12, 1921.*

DEAR MR. WESTER: I have sampled the adlay biscuits you furnished a a few days ago, and I was surprised to find them such good eating. If not superior they are certainly fully equal to Graham flour biscuits, which they much resemble in appearance and texture. It is remarkable, to say the least, that a grain of such good quality should have remained so long in obscurity. In view of the annually increasing wheat flour imports it would appear that adlay as a good wheat substitute cannot help but become an important grain in the Philippines at no distant date.

Very truly yours,
(Sgd.) SILVERIO APOSTOL,
Assistant Director of Agriculture.

THE GOVERNMENT OF THE PHILIPPINE ISLANDS
UNIVERSITY OF THE PHILIPPINES
COLLEGE OF AGRICULTURE, LOS BAÑOS
(OFFICE OF THE DEAN)

March 18, 1921.

MY DEAR MR. WESTER: We have received a package of adlay biscuits—presumably from you, which we have tested with interest. They are certainly good eating.

Dr. Roxas says, "very nice, but not enough!" Miss Kenward says, "very good, but how can we get some of the meal?" Professor Higgins says, "Not hard to take!"

The next point is, how to teach the people to make such good biscuits as these!

Best thanks!

Sincerely,
(Sgd.) C. F. BAKER,
(Dean.)

CAMP NICHOLS, RIZAL, P. I.

April 2, 1921.

DEAR SIR: I am writing to thank you for the adlay biscuits which I received a few days ago and to tell you that I think they were very good and a good substitute for wheat or corn bread.

Yours truly,
(Sgd.) JACOB CASTEEN.

THE GOVERNMENT OF THE PHILIPPINE ISLANDS
BUREAU OF SCIENCE
MANILA

June 3, 1921.

DEAR MR. WESTER: Mrs. Lee and I sampled the biscuits prepared from adlay you sent us recently. We found them even more appetizing than wheat flour biscuits. Is there any source from which we can get this adlay flour for our household use?

Yours truly,
(Sgd.) H. ATHERTON LEE,
Mycologist.

THE GOVERNMENT OF THE PHILIPPINE ISLANDS
BUREAU OF FORESTRY
MANILA

June 14, 1921.

MY DEAR MR. WESTER: In reply to your letter of June 6th, relative to the quality of adlay as a breadstuff, I wish to state that I found it not only very tasty but also satisfying, and in my opinion, adlay biscuits would make a splendid addition to the present generally used breadstuffs. The biscuits served at the Rotary Club luncheon received very favorable comment as to taste, etc., and were heartily appreciated.

Very sincerely yours,
(Sgd.) ARTHUR F. FISCHER,
Director of Forestry.

MANILA, *June 16, 1921.*

DEAR MR. WESTER: I am glad to inform you that the trial of the adlay flour, a specimen of which you gave me about two months ago, has proved most satisfactory. Miss Buelhausen of St. Luke's Hospital conducted the experiment in her children's ward, and had all children from two to twelve years old fed on biscuits made of adlay, substituting it for bread. The experiment on each child lasted from the time of admission till the time of discharge, i. e. several days. All of them seemed to like it, and to thrive on it. The amount of nourishment they received from it was apparently sufficient. They gained in weight; and there were no signs of indigestion. Miss Buelhausen says she could not notice any difference in the amount of nourishment furnished between adlay bread and the wheat bread.

Miss Wiser of the same institution is now conducting another test on the same flour which I received from you last week; and I shall be very glad to give you her report, which I hope will be equally satisfactory.

Sincerely yours,
(Sgd.) A. M. SALEEBY, M.D.

NOTE.—Because of insufficient material the second test was not completed. (P. J. W.)

THE GOVERNMENT OF THE PHILIPPINE ISLANDS
BUREAU OF SCIENCE
MANILA

June 21, 1921.

DEAR MR. WESTER: In reference to the matter of appearance and palatability of the adlay biscuits which you supplied me, I wish to state that from both standpoints they compare very favorably with those made of wheat flour, and provided this cereal can be produced economically on a sufficiently large scale, I see no reason why adlay flour should not be used in combination with wheat flour for the purpose of making bread and biscuits.

Very truly yours,
(Sgd.) ELMER D. MERRILL,
Director, Bureau of Science.

SANTA CRUZ, LAGUNA.
June 30, 1921.

SIR: During the months of March and April of this year, several articles were published in the daily papers regarding a grain called adlay or tigbi, and the possibility of using it as a substitute for wheat flour.

This grain has been grown by the farmers throughout the upland districts of Laguna and other provinces of my district for years but the area generally planted on each farm is small, never exceeding one-half hectare. The local method of planting it is to sow from one to three rows around the outside of the upland rice fields, and there are some instances where a farmer will plant rows of adlay across his field; the rows fifteen to twenty feet apart, and the hills from twenty to thirty inches apart in the row.

To plant adlay for a commercial crop the land should be well prepared. Lay off the field in rows thirty-six to forty inches aparts, drop the seed in the row from twenty-five to thirty inches apart, two seeds to a hill. Adlay should never be planted closer than stated here as the greater number of varieties of adlay send out from fifteen to twenty-five suckers, therefore it is not advisable to plant it close if a good heavy crop of grain is to be harvested.

Adlay has many qualities over other grains that ought to appeal to the dry land rice farmers. First, this grain will stand a drought that would kill upland rice, and still produce a good crop; second, adlay is a plant that locusts don't seem to bother. I have seen upland rice destroyed by locusts while the adlay planted around the field was not touched by them; third, adlay will produce nearly double the yield per hectare that can be expected from upland rice; fourth, the care and cultivation of one hectare of adlay can be carried on at less than one-half the cost of taking care of one hectare of upland rice.

The food value of adlay has been known to the Filipino farmers a long time, and it has been used by them in various forms, such as *Suman* or rice cakes; as *Pinipig*, or roasted; and as a substitute for rice. It also is a first class feed for poultry.

One of the reasons why adlay has never become very popular as a food among the farmers of the country is the trouble they have found in the hulling of the grain, as there are no mills where the farmers can take the grain for hulling and grinding into flour or a rice substitute. Therefore, the hulling is accomplished by pounding out the grains in a mortar used to hull rice, and as the grains of adlay are round and smooth, the farmers are compelled to put a special top about twenty inches high composed of banana leaves around the top of the mortar with the sides of the leaves curved towards the top, leaving an opening of some eight inches for the pestle to pass through. Thus, when the grains are pounded they fly up and on striking the curved sides of the extended top fall back into the mortar. If mills for hulling adlay and preparing it in the form for use as food had been available there is no doubt but that adlay would long ago have become one of our most important grain crops, and if the proposition is taken up now and mills erected where the farmers can have their adlay ground into either flour or grits, or where they can sell the grain to the mill, I am sure that adlay will in less than five years become one of the leading grain crops of the upland or dry land farmer. The work of pushing the planting of this crop through the upland district of the Islands, therefore, should be encouraged by the Government.

Very respectfully,

(Sgd.) W. G. McCarty,
Supervising Agricultural Agent.

THE GOVERNMENT OF THE PHILIPPINE ISLANDS
BUREAU OF EDUCATION

MANILA, *July 2, 1921.*

DEAR MR. WESTER: Replying to your verbal request for an expression relative to the edible quality of adlay, I take pleasure in stating that I found the biscuits tasty, light, and having a peculiar nutty flavor that quite distinguishes them from Graham or wheat flour biscuits to which they are quite equal in edibility; many people might prefer them. The cracked grain, eaten like oatmeal, was of good flavor. It was softer than oatmeal and seemed to lack distinctive flavor. This impression may have been fancied however, and due to the novelty of the food rather than to an inherent quality in the grain. I would like to use it regularly both in the form of breakfast food and flour, where a supply available.

If adlay can be economically produced on a large scale, this grain unquestionably has a future as a staple grain in the Philippines.

Very truly yours,
(Sgd.) R. L. BARRON,
Superintendent, Philippine School of Arts and Trades.

SOME THOUGHTS ON FRUITS AND THEIR CULTURE IN THE PHILIPPINES [1]

It is a great pleasure to me to have the privilege of addressing your conference today, for I have watched the development of the agricultural work of your Bureau with the keenest interest for many years, especially since 1917, when I was made agricultural advisor to the Department of Mindanao and Sulu, where, during my two years' stay, most of my work was carried on through the medium of the schools, and I have become fully convinced that through its agricultural schools and school farms, the Bureau of Education possesses the means of raising the standards of the agricultural practices, including fruit growing, of this country second to no other government organization in the Philippines.

I have been asked to address you on the subject of fruit growing in the Philippines, as you know a rather neglected industry at present, but which like so many other industries has a great future, though it may take some time before it is developed.

Only a few years ago it was taught that, as a rule, fruits were more or less of a luxury, and that they merely pleased the palate rather than furnished nutriment, though it was recognized that many are rich in starch and sugar, and not a few also in protein and fat; but their indispensability is known now that the recent discoveries relative to the vitamines have shown fruits to be exceedingly important dietetically. Fruits and fruit juices are now frequently included in physicians' prescriptions for several ailments. The curative value for certain diseases of the apple, the prune, the orange and lemon, for instance, has already been establised, and as research is extended to other fruits it will probably be found that they, too, are beneficial in various ways. In the meantime the value of fruit juices and acids in stimulating digestion, and the value of fruits in introducing change and variation in what otherwise would be a monotonous diet is to well understood to require further comment.

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[1] A paper read by P. J. Wester, agricultural advisor, Bureau of Agriculture, at the Conference of Farm and Agricultural School Principals, Bureau of Education, in Baguio, May 6, 1921.

When also it is remembered that once established, fruit trees continue to yield abundant crops one year after another, with less care and attention than would any other crop, that they are more independent of rainfall than annual crops, such as rice, corn, and vegetables, and that they are immune to locusts, the advantages to each farmer of possessing an orchard for home consumption of fruits are so great and obvious as to require no further argument.

In discussing the subject of fruit growing, therefore, it should not, and usually does not require much effort to convince the listener that the planting of fruit trees is desirable. And, as a matter of fact, the great trouble is generally to convince him that he cannot grow everything under the sun on his farm.

He already has some fine mango trees, but he has heard of the wonderful mangosteens and the aromatic durians in Jolo, and he wants them; he has eaten lanzones from Laguna and he would like to grow a few of them; if he has been in Baguio he would like a few strawberries, and likely as not he would want to have a few apple trees thrown in for good measure. It is a worthy ambition, but unfortunately it is impossible to achieve.

All of you know by experience of the difference in the climate here in Baguio and in the towns you come from, and you have of course noted the great difference in the vegetation here and at home. Those who have traveled even a little know of the vast difference in climate in the various parts of the Philippines, and they have seen that abacá is grown in one district, coconuts flourish in another, sugar cane is a prominent crop in a third region, maguey in another and so on. These various crops have not become important in the various regions where they grow because some one made up his mind that they should. *They became important crops because the soil and climate favor their development in the parts of the country where they grow.*

When we consider the great number of different kinds of fruits that may be grown in the Philippines, the diversified climate of this country, and the many factors that combine to make a good location for fruit growing, it becomes apparent that any advice offered in a short address must be general in character. A detailed account would require more time than is available. But there are certain fundamental rules that apply in common to all fruit trees and to fruit growing and which must be adhered to in order to insure success. Their violation is equally sure to lead to failure.

In a broad sense, fruit trees in the Philippines may be divided into three groups:

1. Those that succeed where the dry and the wet seasons are distinct and pronounced, such as the mango, tamarind, santol, duhat, guanabano, ates, and related fruit trees;
2. Those that require a moist climate, with fairly abundant rainfall evenly distributed throughout the year, and no long dry periods; or such trees as the mangosteen, marang, durian, lanzon, and the bauno; and finally,
3. Those fruits which are sub-tropical rather than tropical, which do not thrive in the hot lowlands but require an elevation of 600 meters or more to succeed well, such as the cherimoya, the kaki, and the loquat. At a still higher altitude even the chestnut and the peach will be found to thrive.

Some trees have, it is true, a very wide climatological range, but many other species are very impatient relative to their climatic requirements and fail to grow or fruit if planted beyond their range.

Large numbers of fruit trees are set out and die every year, or they make a poor growth because they were planted in a climate where they cannot grow. An attempt to force an unsuitable climate down the throat of a plant, so to speak, is about as sensible as would be an attempt to raise chickens in a duck pond or fish in the poultry yard, and it will be equally successful. Therefore, before you make arrangements to set out an orchard of say, mangos or lanzones, first make sure that the climate and soil in your locality is suitable for the fruit you have in mind. If they are not, it is best not to plant that fruit, but to choose another that will thrive.

While fruit trees may be planted on other lands, other conditions being equal, the largest crops and the best flavored fruit is produced on moderately rich, light, and well drained lands. Too rich soils encourage a luxuriant growth of leaves at the expense of fruit production in the case of a number of fruits, for instance the mango. The trees may thrive on cold, wet lands, but the fruit produced there is not so sweet and fine flavored as that grown on lighter and warmer soils.

In the typhoon belt the susceptibility of a tree to injury from wind should be taken into consideration, and fruit trees known to have brittle, soft wood, with trunk and branches easily broken, should be planted where they are naturally well sheltered, or else effective windbreaks should be set out around the orchard.

This applies to fruit wherever it is grown and whether it is grown for home consumption or as a commercial venture.

If fruit growing is engaged in on a large scale, still other factors enter which determine the financial success or failure of the enterprise.

First, the supply and demand for the fruit in question should be carefully investigated. If the market in a certain locality is over-supplied with mangos and the price received for the fruit is low, obviously it would be inadvisable to engage in mango growing even though the district was well adapted to mangos. Transportation facilities from the point of production to the market should next receive consideration. A locality might produce unusually fine oranges, but orange growing there would be profitless if there were no means of marketing the fruit, or if the cost of transporting them to the market was too great.

Abundant sunlight and air are indispensable for the best results in growing fruit both in regard to quantity and quality. Neither are many flowers nor fruits produced on trees that are crowded, nor are the fruits borne under such conditions so sweet and finely flavored as those produced on trees well exposed to the light and the sun. Then again, trees that are too closely spaced grow tall and spindling in their efforts to reach the light. In consequence, the fruit is more difficult to gather than on smaller trees, the lower branches become weakened and form a breeding ground for diseases and insect pests which spread more easily from tree to tree and are more difficult to control or eradicate where the tops of the trees come in contact. It is evident, then, that proper and sufficiently wide spacing of the trees at the time of planting is a matter of great importance.

It should be a rule never to plant the trees so close that the tops grow together when the trees shall have attained their full size. They should be spaced sufficiently far apart so that when they are full grown the tops are at least from one to two meters apart. Then again, in order to facilitate subsequent work in the orchard and for the sake of appearances and economy of land, the trees should be planted at equal distances and in straight rows.

Finally, when we stop to think that the planting of a fruit tree is nothing less than an epoch-making event, performed once in its life history, that may extend from twenty to over one or more hundred years, the importance of planting the tree properly becomes apparent. As a matter of fact, tens of thousands of trees are annually planted which lead an unhappy life and eventually die for no other reason than that they were not set out as trees should be. The time and care expended in planting a tree properly is the best of economy, for it recuperates the more rapidly, the sooner becomes capable of taking care of itself and beginning to bear.

The two cardinal points for successfully transplanting a tree are:

1. To dig the hole so large that when the tree is planted the roots can be spread out in a natural manner without being bent or forced into an unnatural position when the soil is shoveled back into the hole.
2. Not to allow the plants to dry out or to suffer for want of water from the time they are dug out of the nursery until they have become well rooted in their new place.

For this reason about one-third of the top and most of the leaves should be pruned off the plant before it is dug up in the nursery, and it should not be allowed to lie exposed and dry out in the sun, but should be planted at once, or else carefully wrapped up in wet straw or sacks until it is set out. To save work with watering, the trees should be set out at the beginning of the rainy season. If they are set out during the dry period, they should be watered liberally at the time of planting, and a large basin formed of earth around the tree—one large enough to hold one to two kerosene tins of water—and then covered with a mulch at least 20 centimeters thick. If the mulching is sufficiently thick and wide, two kerosene tins of water applied to a tree once in two or three weeks will carry the young plants through until the next watering.

Then, trees should never be planted deeper than they grew in the nursery. Some recover from it but most trees merely stay alive and fail to make a good growth.

So far as this can be done all trees should be budded or grafted, of course, but that I will leave until some other time.

In order to reduce the expense of bringing an orchard into bearing it is a good idea to plant corn, upland rice, camotes or vegetables in the open space between the trees, but the cultivation of these should not be carried on so near the trees that they are injured by the work animals or the cultivators.

We will assume that we successfully planted a ten-hectare orange or mango orchard two years ago. The trees are looking fine, but are beginning to look more like big bushes than trees, at least the oranges, for though we had heard that trees ought to be pruned we didn't quite know how to go about it so we let them grow according to their own fashion, but now we feel that something must be done.

How should we go about it?

The old fashioned idea was to prune off all the lower branches so as to have a straight trunk five to eight feet high, with a bushy, round top. This makes the orchard a nice place in which to take your best girl for a walk, especially in the spring when the orange trees are in bloom, but unfortunately it is wholly at variance with the modern idea of growing fruits and as you know, in business there is no room for sentiment.

If you could see the orange orchards planted in Florida, California, or Porto Rico within the last 10 years, you would find that the trees are more like huge shrubs or bushes, with no stem at all. They are made to fruit from the ground up.

The young trees are topped systematically and are made to branch near the ground and to spread. This method of training a fruit tree has several advantages over the old "tall trunk" method, of which the greatest are that trees with low and spreading tops are not so liable to typhoon damage as tall trees, and the fruit can be gathered more easily. If insect pests become troublesome the trees can be easily sprayed.

Of course, dead and dying branches and scale infested parts should be pruned out, and also branches that interlock, for they injure each other by wind movement. All prunings should be taken out of the orchard and burned, so as not to serve as a breeding ground for orchard pests.

Before closing I want to say a few words about the Rima, or seedless breadfruit. I have paid considerable attention to this fruit of late, and the more I have learned about it the more am I convinced that it could become a fruit of supreme importance in the Philippines. There are very few trees of the Rima in these Islands, and we do not have more than one or two kinds. In some of the Polynesian archipelagoes up to 30 different varieties are said to exist, some of remarkable yield and quality.

I have just come from a month's trip through the southern islands, and on returning to Cebu I made the acquaintance of an American who lived for many years in the Caroline Islands. He said that there the breadfruit is the principal staple food. It fruits twice a year and the natives have a method of preserving the fruit for use when fresh fruit is not in season. Very little rice is grown there and no corn at all. The breadfruit takes the place of the grains. This gentleman stated that one variety bears fruits up to seven, eight pounds in weight, and that one tree will yield as much as 2 tons of fruit in a year. These are, of course, very large trees. If we reduce this yield to hectare figures and set the trees 20 meters apart, maximum distance, 25 trees to the hectare, and allow for an average production of only 1,000 kilos of fruit per tree we arrive at a yield of about 25 tons of Rimas to the hectare, and from my observations of trees in these Islands I am inclined to believe that this yield is a conservative estimate.

As you all are aware, rice and corn, our two staple grains, are subject to destruction by floods and droughts and locusts. There is not a year when the people in some part of the Philippines are not subject to distress from one of these causes. Many times the suffering is intense among the starving people. The breadfruit is immune both to locusts and floods, and it requires artificial watering only where the dry season is prolonged and pronounced. Think what it would mean, then, if every family had a dozen breadfruit trees to fall back upon when no rice or corn is to be had. It is the best insurance against starvation in the tropics that I know of, and I cannot too strongly urge you to initiate a campaign for the planting of more breadfruits wherever you live.

THE AVOCADO AND ITS PROPAGATION

By P. J. WESTER, *Agricultural Advisor*

The avocado, *Persea gratissima*, is one of the most important fruits in tropical America, including Mexico, the Central American States, the West Indies, Brazil, Colombia, Peru, Ecuador, and the Guianas.

So important is this fruit considered by American authorities that the United States Department of Agriculture several years ago dispatched a trained horticulturist to Central America and Mexico to study the avocado in its native habitat and to procure scions of the best native seedlings. During the two years he spent on this work he obtained such a wealth of promising material and gained so much new information about the avocado that more recently he again has been dispatched to Guatemala for further studies, in the interest of the fruit growers in Florida and California.

The American Department of Agriculture has generously made repeated shipments of plants and scions of the best avocados grown in the United States to the Bureau of Agriculture and the avocado is gradually being established in the various parts of the Philippines. In Manila there have been trees bearing for many years now; there is quite a collection of varieties at the Lamao Experiment Station, and another at the College of Agriculture, Los Baños, and scattered trees are in fruiting here and there, from the Mountain Province to Mindanao.

In its native habitat the avocado is a large, handsome tree, not unlike the santol in habit, but under cultivation, by the aid of grafting and budding, the trees are dwarfed so that they do not grow much larger than a pomelo tree and begin to fruit when they are three years old.

The fruit varies in size from a quarter of a kilo to 2 kilos in weight and is round to oblong, or egg shaped, or with a long, slender neck like a bottle.

In color it varies from green to yellow, red and purple in all shades, to black. The flesh is of a buttery consistency enclosing a large seed and is very rich in a vegetable oil easily digested.

Few fruits are so nutritious as the avocado, and it is one of those few which besides being palatable and wholesome, also have a very high food value. Hence, their extensive planting in the Philippines cannot be too highly recommended.

There are three general races of avocados:

(1) The West Indian race, which can be grown successfully from sea level up to an elevation of about 900 meters.

(2) The Guatemala avocados, which can be grown from sea level up to an elevation of 2,500 meters, but do the best above 700 meters altitude.

The fruit of both these races is very variable in size and shape weighing from about ¼ to 2 kilos, but the skin is thin and the seed generally loose in the West Indian, while the skin is thick and the seed generally filling the cavity in the Guatemala avocado.

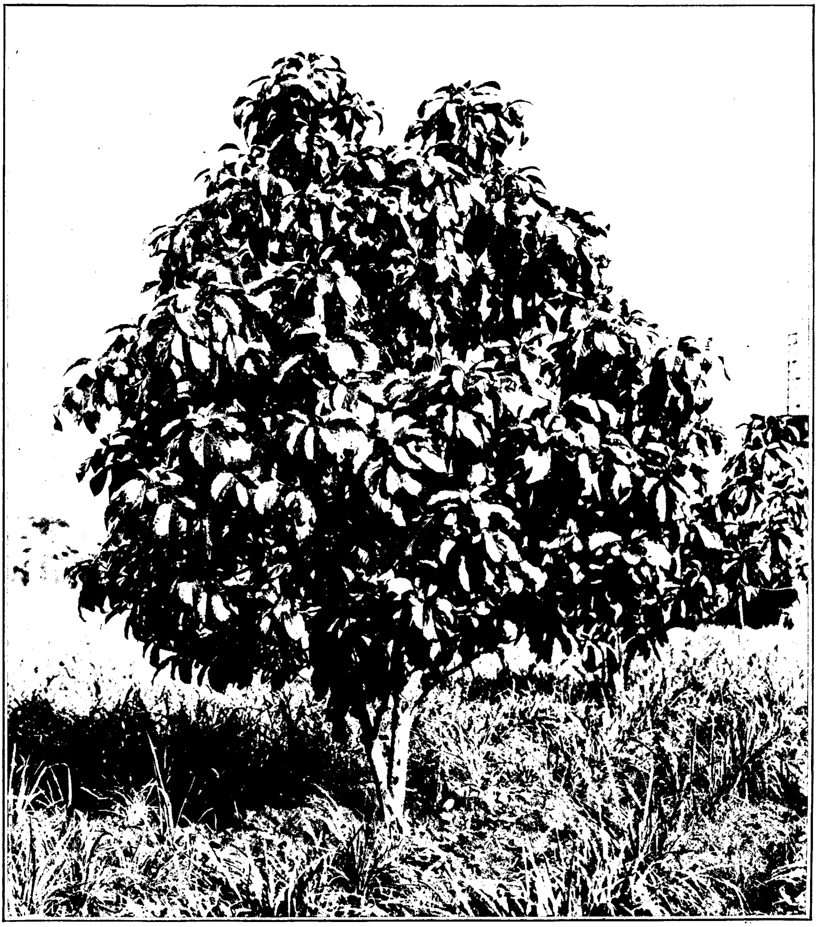
(3) The Mexican avocado is small fruit frequently not larger than a small hen's egg, but the tree is very hardy and can be grown up to an elevation of 2,500 meters or more.

The avocado will not grow on poorly drained land, and no trees should be planted where the land is subject to flooding, or where the water table rises above one meter below the surface of the land. The soil should be at least ½ meter deep and should not be too heavy or clayey. Rather light, porous, loamy, fertile soils are the best.

The land should be cleared of the native vegetation and plowed before staking and planting. Depending upon the variety the trees should be set out from 9 to 12 meters apart, or 123 to 83 trees to the hectare. Holes at least 50 centimeters deep and about as wide should be dug for the young plants, and in setting these out care should be taken not to plant them deeper than they grew in the nursery, or they will fail to make a good growth. It is also important that good surface soil be used to fill the holes in planting the trees.

Wherever irrigation is available the avocado can be grown in the Philippines within the limitations set forth relative to elevation and soil. Where water cannot be had during the prolonged dry season throughout the central Luzon plain and Ilocos, the planting of the avocado is not advisable. The tree flourishes to perfection where the rainfall is abundant and well distributed, as in Mindanao, Samar and Leyte.

Seedlings may be grown but budded or grafted trees are much to be preferred. The following is an exposition of the methods of propagation of the avocado practiced repeatedly on a large scale by the writer with uniformly good results.



Avocado tree three years old, Singalong Experiment Station.

Very susceptible to injury from fungi, the seed of the avocado loses its viability very rapidly on being exposed to the air, and it should, on that account, be planted as early as possible after it is taken from the fruit. Where delay is unavoidable, the seeds should be covered by moderately moist soil. Seeds treated in this way can, however, be left for a short time only, as germination, in most cases, starts very early, much more so than in the seed of the mango.

There are two methods of propagating the young plants: (*a*) To grow and bud the stock in pots or boxes, and (*b*) to plant the seed in the nursery, bud the stock there, and afterwards take up the budded plants, transplant them to boxes or pots, and grow them in a plant shed until they are large enough to set out in the field. The direct transfer of plants from the nursery to the field has never been done on an extensive scale, so far as the writer is aware. In Florida, where on account of its sandy character, the soil does not adhere well to the roots, the avocado transplants with more difficulty than citrus trees, but in loamy and clayey soils where the plant can be taken up with a ball of earth around the roots, it can be moved without serious trouble.

If the plants are to be grown in pots or boxes the seed should be planted in pots 15 centimeters in diameter, or boxes 12 to 15 centimeters in width and 25 centimeters in depth. The bottom of the pot or box should be covered with broken potsherds, coal ashes, small stones, or gravel, to provide proper drainage, and the seed should be covered about 15 to 20 millimeters with soil. Sandy loam, rich in humus, is good potting soil. After planting the seed, the pots should be plunged in a frame in a plant shed, giving about half shade, and should be covered with a thin layer of straw or leaves to prevent evaporation and washing out of the soil by heavy rains. The watering required is ordinarily, at this stage, very slight, but the pots should be looked after frequently to see that the soil does not dry out. On the other hand, the soil should not be kept wet and soggy by excessive watering. In two or three weeks after the seeds are planted the first plants begin to appear above ground, and as they reach a height of 15 to 25 centimeters they should be shifted to another frame and given more room, other condition being favorable. As soon as the plants in pots are about 25 to 30 centimeters high they are shifted to a larger sized pot or box, 18 to 20 centimeters across, and may be budded as soon as they have attained the thickness of a lead pencil. The plants should remain in the pots or boxes until they are set out in the field. If the plants are grown in receptacles a plant shed should be erected, constructed so as to give half shade to shelter them from wind and sun.

No one who is not well versed in the care of potplants should attempt to grow the stock-plants and bud them in pots or boxes, or else the result is sure to be discouraging—if not a complete failure. It takes an experienced man to keep the plants not only in a growing condition, but in a condition of perfect health with the sap flowing freely, and in condition for budding. To do this the plant should receive a certain amount of water from day to day and this only a trained man can rightly gauge. If overwatered the soil sours, the roots decay, and the growth of the plant is suspended; if too little water is given, even for a day, the cambium layer dries up and the bark sticks to the wood as if glued; in either case budding is impossible. Also, the plants should be examined every three weeks, if not oftener, and all roots that have started to grow through the drainage vent cut off. If this is not attended to the greater part of the root system of the plant will soon have formed outside of the pot. The avocado is a voracious feeder and soon exhausts the available food supply in the pot, and the fertility of the soil must be renewed by artificial means. Where cow manure is available, this may be mixed with water, strained through a sieve or a coarse cloth into a barrel and diluted until it assumes the color of weak coffee; the plants should then be watered with this mixture once in two or three weeks, according to their condition. Frequently manure is not readily obtainable, however, and resort must be had to artificial fertilizers. Only the most soluble chemicals should then be used, those that furnish a plant food immediately available. The writer has for several years used the following formula for many kinds of tropical plants (including the avocado, mango, annonaceous plants, guavas, etc., and different palms), applied at intervals as directed for the manure water, with highly satisfactory results:

Nitrate of soda	grams	275
Sulphate of potash, 49 per cent	do	125
Acid phosphate, 16 per cent	do	350
Water	liters	100

Care should be taken to see that all the constituents are well dissolved. The acid phosphate has a tendency to settle at the bottom and the solution should, therefore, be stirred up now and then.

If the plants are to be budded in the nursery the seed should be planted about 20 centimeters apart and covered with 15 to 25 millimeters of soil in rows laid off 1 meter or more apart to suit the convenience of the propagator. If the soil is dry the land should be well irrigated after the planting of the seed, and the rows where the seed is planted covered with a mulch of straw or leaves. In order to induce the plants to develop a better lateral roots system the rows should be gone over when the plants are about 15 centimeters high, and a sharp-edged spade thrust diagonally into the ground under each plant, cutting off the taproot about 10 to 12 centimeters below the surface of the ground. The weeds should be kept down by frequent shallow cultivation. Deep cultivation should be avoided.

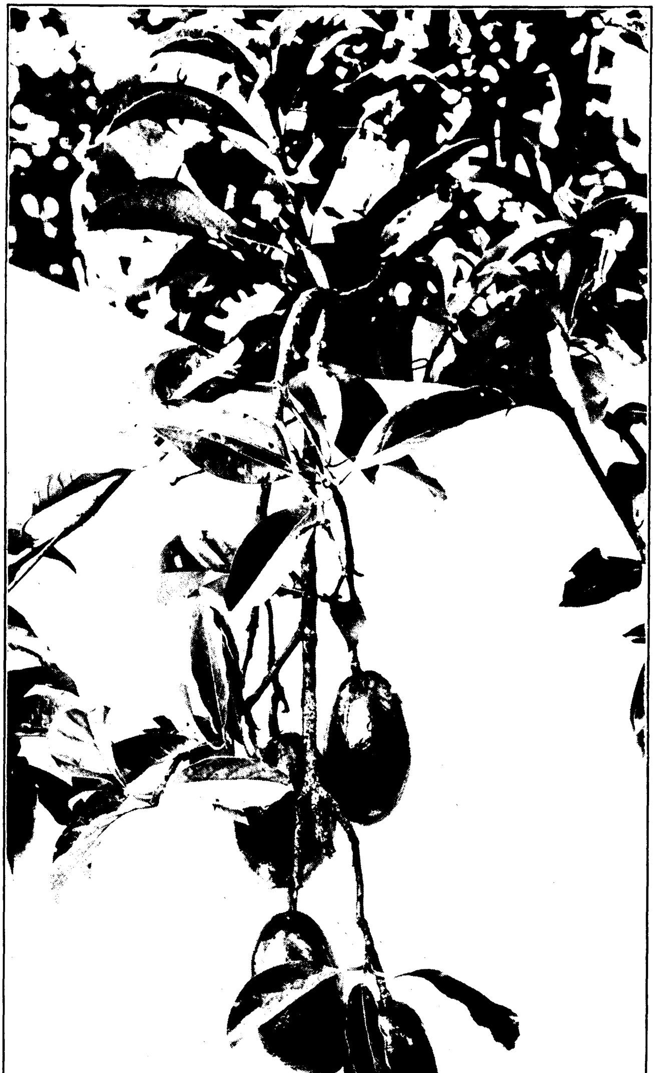
For propagating work in the nursery the simplicity of the method, the rapidity with which the work may be performed, coupled with great economy of material—a valuable feature where this is scarce—renders the method of shield-budding preferable to all other methods of propagation. The avocado, fortunately, responds well to this method.

Much has been said about the difficulty of budding the avocado, particularly in regard to the failure of the buds to start; but *if proper precautions are taken* it is only slightly more difficult to bud than the orange or the peach. The principal difficulty has been mainly with the operator, who has lacked the manual skill necessary for success and the good judgment necessary for the selection of buds; not infrequently it has been due to a poor budding knife. Budding and grafting of a plant are analogous to a surgical operation on a human being, but the man who would be horrified to see a surgeon pull out of his pocket a rusty and dull jack knife to perform an operation will frequently go to work and bud avocados or other plants with just such a knife and then wonder why so many buds failed to grow. The wonder is that any grew at all. Not only should a budding knife made expressly for the purpose be used for this work, but it should be absolutely clean from all impurities and have an edge keen as a razor. A small whetstone and leather strop should be included in the working tool kit so that the knife can be sharpened as needed. The writer, in his budding work, frequently tests the keenness of the blade on his forearm; if too dull to smoothly shave the hair the knife is ground or honed before another bud is cut.

Budding should never be attempted unless there is a good flow of sap, so that the bark separates readily from the wood. Old, hard budwood should not be used, for—unlike the citrus, anonaceous fruits, and several other plants, the buds of which are sunk into the bark tissue from which new buds issue if a sprouting bud is broken off—the buds of the avocado are mostly raised above the bark; consequently if a bud fails to sprout, it frequently falls off even before the leaf itself has dropped, thus leaving a blind bud incapable of producing any growth whatever. Because of this feature of the avocado and the tendency of the old buds to drop, the use of old budwood will always be accompanied by a certain percentage of loss from buds going "blind" even after a perfect union between stock and scion has become established. Another reason for the failure to get the buds to sprout complained of by some propagators, is that the buds are cut too small and that the leaf buds proper are small and poorly developed and unable to start before the rapidly growing callus around the bud smothers it. The importance of the selection of budwood from the current year's growth—sufficiently mature so that it does not snap on bending, carrying vigorous and well-developed buds that are not crowded on the budstick, thus allowing the cutting of large buds, cannot be too strongly emphasized. Suitable budwood may be "made to order" by manuring the trees heavily with nitrogenous fertilizer and irrigating them a few months before the budwood is wanted.

After the wood has matured as indicated, there need be no fear that it is too tender. In fact, the tenderest full-grown buds may be used with success in the hands of a skilled budder. The writer has frequently used the tip of a budstick, inserting it as a "side graft" with good success. The bud should be inserted as near the ground as possible, for this will save much time later otherwise consumed in rubbing off adventitious buds, and the buds also have a tendency to start easier when inserted near the ground than when placed higher up on the stock. In countries where light frosts may be expected during the winter, it gives a better opportunity to protect the bud by banking the tree with soil than if the bud is inserted far above the ground.

In preparing the stock to receive the bud, make a vertical incision about 35 to 40 millimeters long, at the lower end of which make a horizontal incision as shown in Plate XI. Then lift the bark by passing the point of the blade under the bark upward from the horizontal incision making a wound suggesting an inverted T. The T bud may also be used and the bud is then pushed downwards, but making the inverted T bud has been found to be the more advantageous and expiditious method. The bark should be lifted sufficiently so that none but the gen-



A fruiting branch of the Lyon avocado, Lamao Experiment Station.

tlest pressure is needed to insert the bud in position. Now cut a bud, of the size shown on the accompanying Plate by passing the knife diagonally under the bud, taking care not to cut the bud too thin, and that no tear or break is made in the tissue; place the bud in position and tie firmly but not tight enough to strangle with grafting tape; begin at the horizontal cut and cover the entire bud to prevent its drying out and to prevent access of water. In the light of the experiments conducted by the writer the avocado may be budded at all seasons of the year; though in large practice it is best not to bud at the approach of the dormant period, for the reason that the buds then sprout with more difficulty than at other seasons, in the meantime being in danger of becoming callused over.

For tying material, raffia, soft cotton string, or grafting tape is used. The writer has found grafting tape preferable, as it prevents the drying up of the bud before circulation has been established between scion and stock, and excludes all extraneous moisture, which, when other tying materials are used, frequently enters the bud and destroys it.[1]

If the weather is warm and the stock is in growing condition, the union will take place in two weeks, sometimes even in a shorter period, and the buds are then unwrapped to below the leaf bud, and the top of the stock lopped about 7 to 10 centimeters above the bud. If, on examination, it is found that the union has not yet been formed, replace the wrapping for another week. It is important that in a vigorous and rapidly growing species like the avocado, the unwrapping and lopping be attended to as soon as there is a good union, as otherwise the callus soon grows over the bud and smothers it before sprouting, one of the difficulties experienced by amateur operators. In order to force the bud to start it is no less essential that all adventitious sprouts be rubbed off as soon as they make their appearance.

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[1] A wax preferred by the writer in grafting or for making wax cloth is made of equal weights of beeswax and rosin.

The wax is prepared by placing the ingredients in a suitable iron pot and melting them over a slow fire. Liquid wax may be made by melting 1 kilogram of wax made as mentioned and adding 0.75 liter of alcohol; mix thoroughly and keep in a tightly corked bottle.

The best material for grafting tape is cheap cotton cloth that tears easily; tear up the cloth into strips 15 to 20 centimeters wide; wind the strips of cloth on stout iron wire until the roll is not more than 4 centimeters in diameter; if thicker the wax will penetrate with difficulty to the center. To prevent the cloth from being undone tie a string around each end of the roll. The weight of the wire causes the rolls to sink in the mixture while the cloth absorbs the wax; if sticks of wood are used on which to wind the cloth the rolls should be weighted down. Place the rolls in the melted wax which will saturate the cloth in about fifteen minutes. Do not place the rolls of cloth in the mixture in boiling state or the cloth may be burned. When ready to use unroll the cloth and tear it into strips about 20 millimeters wide.

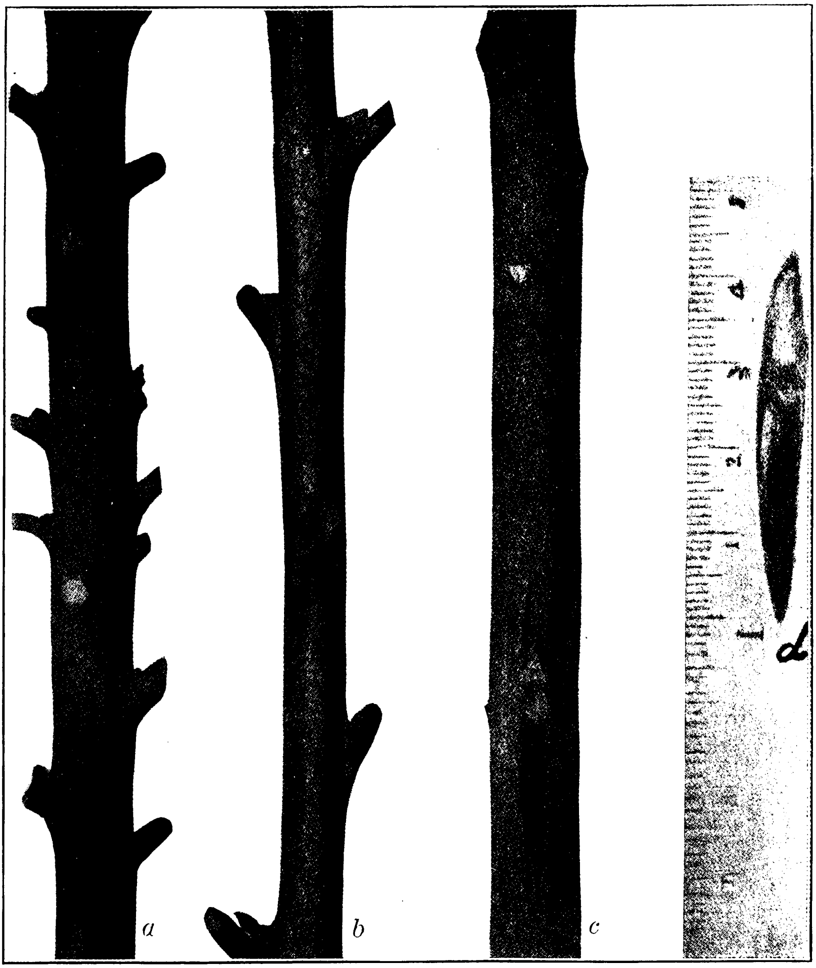
After the bud has made a growth of 15 to 20 centimeters and ripened up its wood, the stock should be trimmed off by a sharp knife immediately above the bud. The cut should be covered with grafting wax or paint to prevent the entrance of fungi which, if this is not attended to, frequently enter the stock through the wound that is made at the point of lopping the stock, working downward until they destroy the bud. Their presence is shown by the brownish appearance of the bark and wood. The only means by which a budded plant attacked in this way may be saved is by trimming off the stock to the bud and covering the cut with grafting wax, linseed oil, or paint.

After being trimmed the plant is left in the pot until the wound is healed, when it is ready for planting in the field. If the pot-grown plants have been given good attention and budded at the proper time the majority should be ready for the field a year from planting the seed—the more precocious even earlier. In a well-conducted nursery all stocks should be budded before they are six months old.

Where the plants are transferred to boxes before planting out this should be done after the wound is fairly well healed up. Before taking them out of the ground prune off about one-third of the foliage. Great care should be exercised to prevent the roots from drying out or from being bruised. In "boxing" the plants, carefully work the soil in among the roots and allow them to remain in as natural a position as possible. Water the plants thoroughly and keep them well shaded for a few days. When they have thoroughly established themselves they are ready for transplanting to the field.

In Florida it has been found that old seedling trees are easily cleft grafted, particularly if they are not beyond the age of five years.

In order to stimulate the flow of sap, it is an advantage to fertilize the trees which are to be grafted with a mixture containing a fair amount of nitrate of soda about a week in advance of the date when the grafting operation is to be performed. The main trunk (or trunks if there are more than one) is then sawed off from 30 to 90 centimeters above the ground, all limbs on the stump being allowed to remain. Owing to the fact that the wood of the avocado does not split well it is best to make the vertical cleft about 12 centimeters long in the stump with a



Shield budding the avocado; (*a*) Twigs like this do not make good scions, because the buds are too crowded; (*b*) ideal budwood; (*c*) shield bud inserted in the stock; (*d*) shield bud.

saw instead of grafting tool. A wedge is now driven into the *center of the cleft* sufficiently deep to open it so that the edges may be smoothed with a knife. This should be done very carefully so that the stock and scion make a snug fit at the point of contact, for upon this depends largely the success of the operation. Then remove the wedge and insert one made of "green" wood, say of the tree just cut down. The scions should, of course, be taken from trees with a good performance record and should be cut from the second or third growth from the last "flush," with dormant buds and preferably from dormant trees. Scions having several blind buds should be discarded. The scions should be from 15 to 20 centimeters long and the lower part cut into a long, tapering wedge that will extend nearly to the bottom of the cut, leaving 7.5 to 12 centimeters of the scion extending above the stump. Two scions should be inserted at each side of the cleft. After the scions are inserted the wedge in the center of the cleft should be moved to and fro until it can be withdrawn sufficiently to allow stock and scion to come in perfect contact, *but not so much so that the latter is crushed or bruised* by the pressure from the cleft in the stock, after which the wedge should be sawn off smoothly, even with the stump. All wounds should be hermetically sealed with grafting wax to exclude the entrance of water and to prevent evaporation from the stock and scion, after which the top of the stump and the cleft should be carefully wrapped with grafting tape. Finally the upper part of the stock should be wrapped in heavy Manila paper or light card board so as to form a loose cylinder around the union, and extending about 10 centimeters or more above the top of the scions. This cylinder should be filled with clean, dry sand up to within about 2 centimeters of the top of the scions. The sand will protect the scions from drying out and the upper part of the paper cylinder will shade them. Ordinarily the graft will begin growing in the course of two to three weeks, though sometimes four to six weeks elapse before the buds starts to grow. Where union fails to take place the young growths of the stump may be shield budded as soon as they are large enough.

The dead, exposed wood of the stock should be kept carefully waxed in order to keep out decay until the wound is entirely healed. This will require a period of from one to four years, depending upon the size of the stock when the grafting is performed.

In Florida where cleft grafting of old seedling trees has been practiced quite extensively it has been found that the new tops frequently bear a crop even the year after the grafting was performed, and heavy crops of fruits are produced the second year.

The trees should be set out at the advent of the rainy season, and should be spaced from 9 to 12 meters apart, and when this is over they should be heavily mulched, and the land plowed and, in order to conserve the water in the soil, harrowed. Subsequently the care given other rationally handled fruit trees will answer equally well for the avocado. For more detailed directions pertaining to orchard management see Bulletin No. 32, *Plant Propagation and Fruit Culture in the Tropics,* which may be had upon application to the Director of Agriculture, Manila.

MINDANAO: SOME SUGGESTIONS RELATIVE TO ECONOMIC DEVELOPMENT[1]

By P. J. WESTER, *Agricultural Advisor*

Mindanao is still a comparatively unknown land. Less than half a score of men have traveled widely enough to know it well, and much of the information gained has never found its way into print. Meteorological data are scant for extensive areas. No complete systematic geologic and soil survey has been made. In a botanical sense the interior of the island is only partly explored. But it is evident even to the casual traveler that Mindanao is very rich in natural resources, and capable of production of the great tropical staples of commerce on a very large scale.

Because of the lack of information on the subject, during his service as agricultural advisor to the Department of Mindanao and Sulu in 1917–1919, the writer made an effort to gather data having a bearing upon the economic development of Mindanao, which lead to the preparation of a series of articles appearing in this REVIEW in 1920.

In order to enable the readers of these articles to comprehend the geography of the island as a whole, the interrelation of the provinces and localities referred to, and to visualize the ideas expressed relative to a future transportation system and ports better, it has seemed desirable to supplement these articles by a general review, accompanied by a map of Mindanao, and marine charts of the northern part of Davao Gulf and of Zamboanga and vicinity.

The second largest of the islands in the Philippine Archipelago, Mindanao was first discovered by the Spaniards. It is 36,906 square miles in extent and about equals in area the State of Indiana; it is some 11,600 square miles larger than Ceylon, nearly ten times the size of Porto Rico, and more than three times as large as Belgium. The population numbers somewhat less than 800,000 souls or about 22 to the square mile. Everything considered, it is the richest in natural resources, yet it is the least developed of all the larger islands, and much of the land still remains unexplored.

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[1] Plate XIII and have XIV been made from maps courteously furnished by the Director, U. S. Coast and Geodetic Survey, Manila, who also provided a map used by C. N. Villanueva in tracing the map shown on Plate XII.

While Mindanao was the first island in the Philippines on which Magellan landed on his arrival 400 years ago, the Spaniards never gained full control there and were still warring with the Moros at the time of the outbreak of the Spanish-American war in 1898. Intermittent warfare continued between the American troops and the Moros some years after American occupation of the Philippines until civil government was inaugurated in 1914, and the present provincial divisions were established as parts of the Department of Mindanao and Sulu; Misamis and Surigao excepted, which were organized as provincial units by the Spaniards. In 1919, the Department of Mindanao and Sulu in turn was abolished and the provinces placed on the status of the older provinces in the Philippines.

Climatically, Mindanao is more favorably situated than all the larger islands in the Archipelago to the north. The northeastern corner excepted, Mindanao is below the so-called typhoon belt. As a whole, the rainfall is more equally distributed throughout the year than in Luzon and the Visayas.

Dividing the island into three zones the Rev. José Coronas, chief, meteorological division, Weather Bureau, in the *Climate and Weather of the Philippines, 1903 to 1918,* says that eastern Mindanao from about the head of Davao Gulf to Bagakay Point, south of Camigin Island, is of the second type with no dry periods and the maximum rainfall in the winter; and, excepting Bukidnon north of about the eighth parallel and Misamis east of Lanao, and the western part of the Zamboanga peninsula to about 122° 30′ east longitude which belong to the intermediate "A" type with no pronounced maximum rain period and a short dry season lasting from one to three months, the rest of Mindanao belongs to the intermediate "B" type with no pronounced maximum rain period and no dry season.

The topography of the country renders an unusually large proportion of the island available for agricultural purposes, and the soil is virgin and exceedingly fertile. Practically every tropical crop can be grown there.

Of the total area of approximately 9,850,000 hectares, it is conservatively estimated that three-fifths is good agricultural

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land. But let us assume that only 3,000,000 hectares are in cultivation to seven of the leading crops. The crops that, at a very conservative estimate, might be harvested from this area as shown in the following table are suggestive of the potential agricultural wealth of Mindanao:

Crop	Area, hectares	Yield, metric tons
Rice	400,000	520,000
Coconuts (copra)	600,000	600,000
Rubber	500,000	150,000
Coffee	400,000	240,000
Tea	200,000	270,000
Abacá	300,000	180,000
Sugar-cane (sugar)	200,000	1,200,000

The forests of Mindanao are very extensive and will furnish large quantities of excellent lumber for domestic consumption and export for a long period of years, aside from minor products, such as rattan and almaciga. There are approximately 90,000 hectares in mangrove from which large quantities of tanning extracts could be obtained. And by planting nipa palms to take the place of the mangrove an inexhaustible source of motor fuel would be provided. Nipa is already found in many places on the sea coast, and the largest nipa swamp in the Philippines, approximately 9,000 hectares in extent, is located in Lanao Province on Pañgil Bay. According to the investigations made by the Bureau of Science, systematically tapped for alcohol manufacture, this could be made to annually yield more than 17,500,000 liters of 90 per cent alcohol. In the face of the annually increased importation of motor driven farm machinery, trucks and automobiles with a correspondingly increased importation of gasoline and other petroleum derivatives at steadily advancing prices, the value of the nipa swamps as a future source of motor fuel assumes more than ordinary significance.

Should the coal beds of Malangas and the oil deposits in Pidatan prove sufficiently extensive they would prove another source of wealth of inestimable value in connection with the development of the Philippines.

The waters surrounding Mindanao abound in fish of many kinds and fisheries of large proportions could be developed.

Except in Davao, where it has been imported for several years, labor is still available for operating moderate sized plantations, but development of projects of any considerable magnitude presupposes the importation of practically all labor as a matter of course.

The many rivers with their numerous falls and rapids would be a valuable source of power for industrial and transportation purposes and for irrigation. The Agusan and especially the Cotabato River could also be developed into important waterways. In considering the internal transportation problem relative to the future economic development of Mindanao in its broadest sense, in relation to the topographical features of the island, including that of convenient outlets for the largest and the most fertile regions through natural harbors where port works could be most economically constructed, combined with well drained, attractive town sites, the routes traced on Plate XII with the assistance of former Major G. O. Fort, Philippine Constabulary, than whom no one is better informed relative to the topography of Mindanao, are suggested as the most advantageous and along the lines of least resistance.

The natural advantages of Nasipit, Parang, and Malalag for terminals have already been discussed in the articles on Agusan, Cotabato, and Davao, and are too obvious to need further comment. More exposed, Kolambugan, next to Nasipit, has the greatest natural advantages for a railway terminal and deep water port on the north coast of Mindanao. Cagayan also has been proposed as a terminus but the limited area for anchorage, the poor town site, combined with the probable high cost of construction of a railway climbing from Cagayan to the Bukidnon plains, would be likely to militate against a road being located there, considering the more favorable approach to the interior through a richer agricultural country from Parang or Kolambugan.

For a road passing through the rich Cotabato Valley to Sarangani Bay, Makâr or possibly Buayan would be the best terminal. On the line from Nasipit to Malalag one branch line to Lianga Bay and another to Mati on the Pacific coast may be found advantageous, and still another to Hijo at the head of Davao Gulf which is probably preferable as a town site to swampy Tagum. On the way to Malalag the road would pass through or a short distance west of Davao, but because of the low and swampy land, shallow water and the open, unprotected roadstead at Santa Ana, the landing place, it is not believed that the establishment here of a large deep water port is warranted in face of the superior advantages of Malalag with its land locked harbor, where the ships can approach closer to the shore, where the land is higher and well drained, and affords a good town site.

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In short, the arguments in favor of the development of a port at Caldera Bay presented on another page are equally pertinent relative to the location of a large deep water port at Malalag instead of Davao. The anchorages at Digos, Mampissin, and south of the mouth of the Lasang River are also worthy of note.

The strategic location of the point of the Zamboanga Peninsula of Mindanao, facing Basilan Strait, on the line of travel from Australia to Manila, Hongkong, and Japan (Plate XIV)—it is the logical place for a port of call for steamers plying between Singapore and Borneo, the point where all interisland steamers must pass and meet on their way between Manila and the Davao and Cotabato ports and Jolo, and from the north to the south coasts of Mindanao—is an assurance that here will always be one of the most important seaports in the Philippine Archipelago. And its activities will inevitably expand coincidently with the development of Mindanao, for which island it will remain the central supply depot and port of entry for the machinery, supplies, and foodstuffs that will be required for importation incident to the opening up of this great island, at least until an adequate transportation system shall have been developed in the great agricultural regions, uniting them with more convenient shipping points such as conceivably may be established at Parang, Nasipit, Kolambugan, and Malalag. At present Zamboanga is the port of call on the Basilan Strait. A pretty little town, Zamboanga unfortunately lacks natural advantages for growing into a big seaport. Located at the point of the peninsula, the port area has no protection from storms though fortunately they are rare. The water is shallow, necessitating the construction of long, expensive piers in the event of its development into a port of more than ordinary importance. The swift sea current near the shore renders the approach to the docks difficult, if not dangerous. The town site itself is flat and unattractive, being a beach exposed to tidal waves, with a swamp for a background, into which the town is already expanding.

How Zamboanga "happened," so to speak, during the turbulent days when Spain was endeavoring to extend her empire in this part of the world is well known. But with the pacification of Mindanao the powerful motives which compelled the Spaniards to abandon their early settlements at Caldera Bay and Masinlok and build another at Zamboanga, where they were less exposed to danger from attacks of the Moros, have disappeared.

With two natural harbors a short distance away—Caldera Bay and Masinlok Anchorage—there seems now to be every reason why a new port should be developed. Of the two harbors Masinlok is the roomier and has the greater natural protection, but the entrance is dangerous because of strong currents and shifting beds; the adjacent land is low, swampy, and unattractive. The natural harbor of Caldera Bay is smaller, but sea currents are absent and do not interfere with navigation in entering the harbor. The rising hills on one side would afford an excellent town site, and the flat land back of the head of the Bay could be dredged out for large docks. Where it would be desirable to raise the low area this could easily and cheaply be accomplished by sluicing down earth from the hills near by.

As a matter of fact Caldera Bay because of its natural advantages for many years has served as a "coaling station" in this part of the Philippine Archipelago, and is used as a harbor for steamers during stormy weather. Indeed, the superior advantages of Caldera Bay as a harbor were early recognized by the Spaniards, as far back as 1596, and used as a base of operations during their warfare against the Cotabato Moros. When it is considered, too, that no amount of money will ever make a Caldera Bay out of Zamboanga harbor, it is believed that a careful investigation by competent engineers, navigators, and economists would show that a transfer of the port would be justified as an economically sound move.

In fine, the development of a port at Caldera Bay would be attended by the following advantages over that at Zamboanga:

(1) Easier approach to the port.
(2) Superior anchorage closer to the shore.
(3) Better protection for the shipping during bad weather.
(4) Quicker and cheaper coaling of steamers.
(5) Cheaper harbor and wharf construction.
(6) A greatly superior and more attractive town site with adequate protection against tidal waves.

It has been said that the Philippines is the richest undeveloped region on the earth today. A broad statement. That it stands in the front rank is unquestioned, however. As the second largest island in the Archipelago and well known to possess greater natural advantages than any of the others, therefore, the development of Mindanao presents a fascinating sub-

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ject to the student of economics, and an unusual opportunity for constructive statesmanship. But before permanent public improvements of any magnitude are undertaken, it would appear prudent and desirable to make a thorough physiographic survey of the island and work out a comprehensive and detailed plan for the construction of highways, ports, and irrigation works, which should be located less with an eye to the negligible present than to serve the greater future.

SEEDLESS BREADFRUITS IN THE CAROLINE ISLANDS

By P. J. WESTER, *Agricultural Advisor*

PRELIMINARY REMARKS

It is true that the literature on the breadfruit is rather scant. Nevertheless it is a remarkable fact that notwithstanding the more or less enthusiastic accounts of this so important fruit in the South Sea Archipelago, no horticultural writer has ever recorded the names or described any of the numerous breadfruit varieties which are reported from these Islands.

In fact this lack of definite information about the reputed breadfruit varieties seemed so singular that after writing the article on the breadfruit which appeared in this REVIEW, Vol. XIII, No. 3, 1920, the writer made a search for references to the breadfruit in South Sea literature. Practically every work consulted refers to the breadfruit and dwells more or less on its value and uses. Some speak of the large number of varieties—one writer mentions the occurrence of about 50 kinds in the Marquesas—but the only book in which actual names are given is "The Caroline Islands," by F. W. Christian, published in 1899.

Since this book may be unknown or difficult of access to many who are working with tropical fruits an alphabetical list is given as follows of the breadfruit varieties mentioned by Christian, with such brief notes about them as he has given. All these varieties are distinctly said to be seedless.

The length of the list is quite remarkable, and may perhaps be accounted for by the names being in different dialects so that several names refer to one variety. For it seems improbable that there can be so many distinct varieties of seedless breadfruits in one little Archipelago. However that may be, we are indebted to the author for the first recorded list of breadfruit varieties, which altogether makes the breadfruit more tangible as it were.

In the Carolines the breadfruit is known as *Mai*. All the varieties except those noted (undescribed) from Yap were recorded from Ponapi.

List of breadfruit varieties

APIL. A small round fruit.
CHAI. A smooth fruit.
CHANIAK. A small fruit.
EN-CHAK. An oblong fruit.
EN-CHARAK. A fruit with spiny surface.
EN-CHERRICHANG. A small fruit with a reddish, spiny surface.
EN-KAUALIK. A long fruit with rough surface.
EN-KOTOKOT. A small fruit with a spiny surface.
EN-MACHAL. A long fruit.
EN-MONEI. A long, slender fruit with a spiny surface.
EN-PAIPAÍ. An oblong fruit with spiny surface.
EN-PAKOT. A long fruit with a rough surface.
EN-PAR. An oblong fruit with a dark spiny surface.
EN-PATAK. An oblong fruit with a reddish, spiny surface.
EN-PON-CHAKAR. A fruit with reddish, spiny surface.
EN-PO-LE. An oblong fruit.
EN-PUT. A round, small fruit with a spiny surface.
EN-UAOUTAK. A small fruit.
EN-UCHER. A long fruit.
FANUM (undescribed; Yap).
IMPAK. A large, round fruit.
KATIU. A long fruit.
KUMAR. A long fruit.
KALAK. A small fruit with smooth surface.
LIPET. A large fruit with spiny surface.
LETAM. A small, round fruit.
LUATHAR (undescribed; Yap).
LUKUAL. A fruit with more than ordinarily long spines.
MAI-NIOR (undescribed; Yap).
NAKONT. A small, round fruit.
NAN-UMAL. An oblong fruit with spiny surface.
NIUE. A long fruit.
NUE. A large, round fruit with smooth surface. The most esteemed variety.
PAIMACH. A small fruit.
PE-AU (undescribed; Yap).
PEMATHAU (undescribed; Yap).
PON-PANUI. A long fruit with a rough surface.
POTOPOT. An oblong fruit with spiny, light colored (?) surface.
PULANG. A large fruit with smooth surface.

TAGAFEI (undescribed; Yap).
TAIK. A large fruit with smooth surface.
TAKAI. A round fruit, very hard (?).
TAL. A small fruit with a dark, spiny surface.
TI. An oblong fruit with a spiny surface.
UAKA. A large, oblong fruit with spiny surface.
YAE-REB (undescribed; Yap).
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YEO-TUI (undescribed; Yap).
YOA-TATHEN (undescribed; Yap).
YONG. A small fruit.
YU-GOI (undescribed; Yap).
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THE PHILIPPINE

Agricultural Review

VOL. XIV FOURTH QUARTER, 1921 No. 4

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THE PREVENTION OF THE IMPORTATION OF INJURIOUS INSECTS AND PARASITIC FUNGI ON ECONOMIC CROPS FROM FOREIGN COUNTRIES

By H. ATHERTON LEE and GONZALO MERINO

Mycologist, Bureau of Science, and Chief, Plant Pests Control Division, Bureau of Agriculture, respectively

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There are known to exist in foreign countries insects injurious to economic plants and fungi also parasitic on economic plants, which do not yet occur in the Philippines. Examples of such insects in foreign countries are the sugar-cane borer, and the cane-leaf hopper in the Hawaiian Islands. Both of these insects have been very destructive at different periods in that country, although they have not as yet appeared in the Philippines. The Mediterranean fruit fly, found in Australia, Mediterranean countries, and Hawaii, has also caused heavy financial losses, especially in Hawaii. It is not yet in this country.

In the case of diseases due to fungi, there is the Lahaina disease of sugar cane, not yet reported from this country but said to be the worst disease of sugar cane in Hawaii. There is also an infectious disease of cane known as sereh in Java, which is very destructive there; it is not authoritatively known in this country as yet. Gum disease of cane found in Australia and Java also has never been reported here.

The Dumbara disease of tobacco, said to be caused by a fungus, is known in India. It causes the tobacco plants to wilt and die, rather extensively according to the report. It has not yet been found in this country. There is also a nematode, which is very small microscopic worm, known to exist on rice plants in India. It is said to be very destructive in certain localities in their wet season and is gradually spreading. We do not yet have it in the Philippines.

These are only a very few of the insects, fungi, and other organisms which are known to exist in foreign countries but of which we have no knowledge in these Islands. Even in the case of the least injurious of these pests, crops, when affected, lose an appreciable percentage of the normal, or maximum, yield; and such loss, even if but 5 or 10 per cent, when applied to a large estate or the whole output of the country and repeated year after year amounts to extensive damage. These injurious insects, parasitic fungi, and other pests may be introduced by direct importation of plant materials for propagation, either as cargo or as part of the baggage of travelers; in certain instances parasites may be introduced on straw or other plant materials used as a packing substance or for covers, or in soil around small plants or sometimes used for ballast. Fruits brought in, in the hand baggage of travelers are a dangerous source for the dissemination of the fruit fly.

Instances of great losses from insects or fungi introduced into new countries are quite numerous. The Hessian fly which is said to cause more damage to the wheat crop in the United States than any other single insect, is supposed to have been introduced into America from Europe by the Hessian soldiers about the year 1779. Americans who come from New York or Pennsylvania will remember the complete destruction of the chesnut trees in those States in the last ten years due to a fungus which was introduced into America from Japan.

Here at home, in the Philippines, we have the well-known case of the blight or rust of Arabian coffee, which was introduced about 1885. The once prosperous coffee industry centered around Lipa in the Province of Batangas has been entirely wiped out because of the destructiveness of that fungus.

Control of injurious crop insects and parasitic fungi in this country also is especially difficult. There are several reasons for this, the two most important being the nature of the crops and the inability of the Philippine farmer at the present time to take advantage of the known control methods. The important crop plants in the Philippines of course are abaca, coconuts, sugar cane, tobacco, and rice. Such crops, because of their extensive area, cannot be treated with sprays, by the present known methods, in the way that an orchard or field crop can be treated in countries of temperate climates. It has seemed obvious, therefore, that the simplest and most efficient methods of aiding the Philippine farmers in combating insects and diseases is to keep such injurious organisms entirely out, that is, prevent their entrance into the country; should an infestation already be existent in the country, but restricted to only one or a few provinces, to initiate such measures as may prevent the dissemination of the infestation to other provinces or islands.

It is possible by examining or quarantining all living plants, seeds, and fruits which enter these Islands, to intercept any affected with fungi or infested with insects or other harmful animals from foreign countries. Such a course has been adopted in the United States, Holland, Japan, Hawaii, and in several other countries and states. The United States Government has gone even one step further and has entirely prohibited the importation by private persons of nursery stock and certain other plant materials from foreign countries. Importation of such materials can only be effected through the United States Department of Agriculture. The Department of Agriculture is continually introducing new species and varieties of plants into the United States for the purpose of improving agricultural crops, but holds such imported plants under strict quarantine until they have been shown to be free from injurious insects and fungi.

Act 2515 of the Philippine Legislature, enacted in 1915, prohibits "the importation in the Philippine Islands of all plant material or parts thereof or of any material whatsoever which may be used for packing material or covering thereof—except through such ports as may be designated by and subject to such rules and regulations as may from time to time be prescribed by the Director of Agriculture." This Act is quite comprehensive and permits effective measures to be placed in operation.

In 1920, under this Act, a plant quarantine advisory board was appointed by the Director of Agriculture, consisting of five members from the Bureaus of Agriculture and Science, whose duties consist in advising the Director of Agriculture of such rules and regulations as are necessary in the prevention of the introduction or dissemination of diseases or insects.

The rules and regulations, submitted by the plant quarantine advisory board to the Director of Agriculture and approved, provide for the inspection of all plant materials intended for import or export, the refusal to admit such plant materials from foreign countries as may be infested by insects or diseases, or the return to the point of origin of such materials. Plant materials are restricted from entry except at the ports of Manila, Iloilo, Cebu, and Zamboanga, and provision is made for the inspection of plant materials at the piers of such ports and at the post offices.

Because of the inability to detect certain classes of parasites in a single inspection, and because of the entire dependence of the country on certain crops, rules have been submitted and placed in effect providing that all plants of the genus *Musa* (abaca, banana, and related plants) which are desired for introduction must be imported through the Director of Agriculture. This allows of the careful selection of the plants to be imported, a very careful inspection of the plants for insects and fungi upon their arrival here, their fumigation or disinfection, and the propagation of such plants in this country under isolation conditions. If, during such isolation the plants do not develop any disease or insect infestation, they may be turned over to the applicant for such introduction. Similar rules have been approved and are in force for rice, tobacco, coconuts, and sugar cane. Persons or corporations wishing to introduce plant materials of any of these crops, should therefore consult with the Director of Agriculture.

Further regulations are in force to protect the fruit industries of the Philippines, such as the mango, banana, oranges, and other fruits, from the Mediterranean fruit fly.

To the present time only one domestic administrative order has been enacted; this measure prohibited the transportation of plant materials of *Saccharum officinarum,* sugar cane, from the Provinces of Batangas, Laguna, and Mindoro to other provinces. This was intended primarily for the protection of Negros from the destructive Fiji disease of sugar cane. Inasmuch as Fiji disease has developed in Negros, the administrative order is no longer in effect.

It is of course an accepted fact that the welfare of the Philippines at the present time is based upon its agricultural industries. It is not too much therefore to ask that coöperation of the merchants, planters and other individuals be accorded in such few instances where these regulations may cause slight annoyance and inconvenience.

The administrative orders approved by the Director of Agriculture follow:

REGULATIONS GOVERNING THE PLANT QUARANTINE SERVICE OF THE PHILIPPINE ISLANDS

MANILA, *July 16, 1920.*

ADMINISTRATIVE ORDER }
No. 1. }

The Director of Agriculture is authorized by section 1756 of the Administrative Code of 1917 to regulate the importation and exportation of plant materials to and from the Philippine Islands for the purpose of protecting the crops of the Philippines from foreign plant diseases and injurious insects.

Pursuant to this section, the following rules and regulations have been enacted:

SECTION 1. For the purpose of these regulations the term plant materials will include living plants, fruits, seeds intended for reproduction purposes, cuttings, bulbs, grafts, leaves, scions and fruit pits. Plant Quarantine Inspectors are those men so designated by the Director of Agriculture and must have written appointments issued by the Director of Agriculture.

SEC. 2. All persons who intend to export plant materials from the Philippines to another country shall be required to submit such plants together with the packages or the articles used for packing thereof for the inspection of the plant quarantine officials not less than twenty-four (24) hours before the date of shipment. Such plant materials should be accompanied by an Application for Inspection of Plants for Export, Bureau of Agriculture Form No. 144.

SEC. 3. If the plants upon careful inspection are found to be free from parasitic fungi and injurious insects, a certificate shall be prepared and given by the plant quarantine inspector to the exporter to accompany the shipment. A copy of such certificate shall be filed in the Plant Quarantine Office. Plants which show the presence of injurious insects or parasitic fungi should be returned to the exporter without certification. Recommendations can be made that such infested plants be destroyed or, where it seems justifiable, recommendations may be made for treating such plants. Under no conditions shall certificates of freedom from disease be given to plants which have been raised among other plants which are badly diseased or infested by insects. Caution must be used in issuing certificates and they should be given only after careful investigation of the previous history of such plants. Certifications shall not be made for plants of certain species to countries which have a quarantine existing against those plants.

SEC. 4. All persons who intend to import plant materials must submit to the Bureau of Agriculture an Application for Inspection of Incoming Plants, upon a form provided for the purpose (Bureau of Agriculture Form No. 146) on or before the arrival of such shipment. All such plant materials shall be inspected upon arrival for parasitic fungi and injurious insects. All plants which are found to be free from insect pests and diseases shall be certified and tagged with Bureau of Agriculture Form No. 148. Plants shall then be allowed to enter. Plant materials which are found to be infested by insect pests or infected with diseases shall be returned to point of origin or destroyed.

SEC. 5. The plant inspector, in case he destroys plant materials by fire, or causes them to undergo remedial treatment of any nature or prohibits their importation, shall notify the person or persons who presented the application in compliance with the provisions of section 4 of this regulation, and the custom house or post-office officials concerned.

SEC. 6. Persons who import or bring in articles bearing certification that they are free from fungi and insects, issued by the inspector from the country of origin, shall be required to present the certificate thereof to the office of the plant inspector. Presentation of such a certificate, however, shall not in all cases preclude inspection by the plant quarantine officials of this country, although it will be of considerable assistance to such inspection.

SEC. 7. The inspection of incoming plant materials shall be made at the ports of Manila, Cebu, Iloilo and Zamboanga. Plant materials shall not be admitted at any other port.

SEC. 8. Plant materials entering this country through the post-office shall be inspected by the quarantine officials upon notification of the presence of such materials at the post-office. The inspection for passing of such shipment or its destruction shall be the same as for material coming through the custom house. Inspection shall be made in the presence of either the consignee, a post-office official, or both.

SEC. 9. All previous orders and regulations issued concerning plant quarantine are hereby annulled.

SEC. 10. Any person who violates the provisions of the above sections shall be liable to the fine and penalty provided in section 2746, Administrative Code of 1917.

(Sgd.) ADN. HERNANDEZ,
Director of Agriculture.

Approved:
(Sgd.) G. APACIBLE,
Secretary of Agriculture and Natural Resources.

REGULATIONS GOVERNING THE IMPORTATION OF ABACA AND RELATED PLANTS; *MUSA* SPECIES

MANILA, *July 16, 1920.*

ADMINISTRATIVE ORDER }
No. 2. }

Whereas, the products of the abaca plant (Musa textilis) form the principal export crop of the Philippine Islands, the income from that source amounting to more than ₱100,000,000 annually; and

Whereas, there are known to exist in foreign countries insects injurious to, and fungi parasitic upon, such related plants as *Musa sapientum* and *Musa cavendishii* which might also affect the abaca plant:

Therefore, by authority of the provisions of section 1756 of the Administrative Code of 1917, the following regulations shall govern the importation of all plants of the genus *Musa* into the Philippine Islands.

SECTION 1. The importation of plants of the genus *Musa* or any unmanufactured parts of such plants is strictly prohibited; Provided, that importation through the port of Manila, of small quantities of such plants may be permitted in order to secure better varieties for cultivation in this country. Such importation must be made through the Director of Agriculture and must be held in plant quarantine in an isolation station until evidence is available showing that no injurious insects or parasitic fungi are present on such plants.

SEC. 2. Any importation of plants of the genus *Musa* or unmanufactured products of such plants in contravention of the provisions of this order shall be seized by Plant Quarantine Inspectors appointed by the Director of Agriculture, and shall be immediately exported or completely destroyed according to the decision of the Director of Agriculture or his authorized agents, the plant inspectors.

SEC. 3. Any person or persons who shall fail to comply with the requirement of this order shall be liable to the penalties of section 2746 of the Administrative Code of 1917.

(Sgd.) ADN. HERNANDEZ,
Director of Agriculture.

Approved:
(Sgd.) G. APACIBLE,
Secretary of Agriculture and Natural Resources.

REGULATIONS GOVERNING THE IMPORTATION OF COCONUT PLANT MATERIALS (*COCOS NUCIFERA*)

MANILA, *July 16, 1920.*

ADMINISTRATIVE ORDER
No. 3.

Whereas, coconuts are one of the main economic plants of the Philippine Islands; and

Whereas, the products of the coconut plant are the second export of this country, the income from such products amounting to more than ₱60,000,000 annually; and

Whereas, there are known to exist in foreign countries insects injurious to and fungi parasitic upon such plants, which do not yet exist in this country, and which might do serious damage if introduced;

Therefore, by authority of the provisions of section 1756 of the Administrative Code of 1917, the following regulations shall govern the importation of coconut plants or unmanufactured products of the coconut plant into the Philippine Islands.

SECTION 1. The importation of coconut plants or unmanufactured products of the coconut plant is strictly prohibited; Provided, that importation through the port of Manila of small numbers of coconut plants may be permitted for the purpose of promoting the knowledge of new and better varieties here. Such importations must be made through the Director of Agriculture and must be held in plant quarantine under isolation conditions until it shall be demonstrated that no injurious insects or parasitic fungi are present upon such importations.

SEC. 2. Any importation of coconut plants or unmanufactured products of the coconut products of the coconut plant in contravention of the provisions of this order, shall be seized by the Plant Quarantine Inspectors appointed by the Director of Agriculture, and shall be either immediately exported or completely destroyed according to the decision of the Director of Agriculture.

SEC. 3. Any person or persons who shall fail to comply with the requirements of this order shall be liable to the penalties provided in section 2746 of the Administrative Code of 1917.

(Sgd.) ADN. HERNANDEZ,
Director of Agriculture.

Approved:

(Sgd.) G. APACIBLE,
Secretary of Agriculture and Natural Resources.

REGULATIONS GOVERNING THE IMPORTATION OF SUGAR CANE PLANT MATERIALS (*SACCHARUM OFFICINARUM*)

MANILA, *July 16, 1920.*

ADMINISTRATIVE ORDER
No. 4.

General Order No. 40 of the Bureau of Agriculture dated July 29, 1915, is hereby amended to read as follows:

Whereas, the products of the sugar cane, *Saccharum officinarum*, constitute the third export in importance of the Philippine Islands, the income from such export amounting to over ₱30,000,000 annually; and

Whereas, there are known to exist in foreign countries insects injurious to, and fungi parasitic upon, the sugar cane, which do not yet exist in the Philippine Islands; and

Whereas, should such insects and fungi be introduced into this country, they would be a factor tending to decrease the productivity of the sugar cane in this country.

Therefore, as a measure to protect the sugar cane industry, by authority of the provisions of section 1756 of the Administrative Code of 1917, the following rules shall regulate the importation of sugar cane into the Philippine Islands.

SECTION 1. The importation of sugar cane or any unmanufactured products of sugar cane is strictly prohibited; Provided, that importation through the port of Manila of sugar cane plants or cuttings may be made through the Director of Agriculture. Such importations are to be allowed only for the purpose of introducing new and better varieties of sugar cane, which it is believed may be cultivated to advantage in this country, and are to be held under quarantine at an isolation station until they have been shown to be free from all injurious insects and parasitic fungi.

SEC. 2. Any importation of sugar cane plants or unmanufactured products of the sugar cane in contravention of the provisions of this order shall be seized by the Plant Quarantine Inspectors appointed by the Director of Agriculture, and they shall order the immediate exportation of such plants or their immediate and complete destruction, according to the decision of the Director of Agriculture.

SEC. 3. Any person or persons who shall fail to comply with the requirements of this order shall be liable to the penalties of section 2746 of the Administrative Code of 1917.

(Sgd.) ADN. HERNANDEZ,
Director of Agriculture.

Approved:

(Sgd.) G. APACIBLE,
Secretary of Agriculture and Natural Resources.

REGULATIONS GOVERNING THE IMPORTATION OF TOBACCO PLANT MATERIALS (*NICOTIANA TABACCUM*)

MANILA, *July 16, 1920.*

ADMINISTRATIVE ORDER
No. 5.

Whereas, the products of the tobacco plant, *Nicotiana tabaccum*, are the fourth in importance of Philippine exports, the income from that source amounting to more than ₱25,000,000 annually; and

Whereas, there are known to exist in foreign countries insects injurious to, and fungi parasitic upon, the tobacco plant, which do not yet exist in this country; and

Whereas, such injurious insects and parasitic fungi would seriously decrease the amount of tobacco produced in the Philippine Islands;

Therefore, by authority of the provisions of section 1756 of the Administrative Code of 1917, the following considerations shall regulate the importation of all plants of *Nicotiana tabaccum* into this country.

SECTION 1. The importation of all plants or seeds of the species *Nicotiana tabaccum* or of any untreated product of such plants is strictly prohibited; Provided, that the importation through the port of Manila of such plants, seeds, or untreated products may be permitted for the purpose of securing better or more productive varieties for cultivation in this country. Such importations must be made through the Director of Agriculture and must be held under quarantine in isolation until they have been shown to be free from injurious insects and parasitic fungi.

SEC. 2. Any importation of such tobacco plants or untreated products in contravention to the provisions of this order shall be seized by the Plant Quarantine Inspectors appointed by the Director of Agriculture, and they shall order the immediate exportation of such plants or products or their immediate and complete destruction, according to the decision of the Director of Agriculture.

SEC. 3. Any person or persons who shall fail to comply with the requirements of this order shall be liable to the penalties provided in section 2746 of the Administrative Code of 1917.

(Sgd.) ADN. HERNANDEZ,
Director of Agriculture.

Approved:
(Sgd.) G. APACIBLE,
Secretary of Agriculture and Natural Resources.

REGULATIONS GOVERNING THE IMPORTATION OF PROPAGATIVE MATERIALS OF THE RICE PLANTS (*ORYZA SATIVA*)

MANILA, *July 16, 1920.*

ADMINISTRATIVE ORDER }
No. 6. }

Whereas, rice, *Oryza sativa,* is the chief food of the people of the Philippine Islands, and the raising of rice plants forms the principal agricultural industry of the Philippine Islands; and

Whereas, injurious insects and parasitic fungi may exist in other rice producing countries which are as yet unexplored agriculturally; and

Whereas, such injurious and parasitic fungi if introduced into this country might seriously decrease the production of rice, thereby increasing the cost of production and the price to the consumer;

Therefore, by authority of the provisions of section 1756 of the Administrative Code of 1917, the following rules shall regulate the importation of rice plants and untreated rice products into this country:

SECTION 1. The importation of rice plants, seeds or untreated rice products is strictly prohibited; Provided, that importation through the port of Manila of such rice plants or rice products may be made for the purpose of improving the present rice varieties in this country. Such importations must be made through the Director of Agriculture and must be held under quarantine in isolation until they have been shown to be free from all injurious insects and parasitic fungi.

SEC. 2. Any importation of rice plants or untreated products in contravention to the provisions of this order shall be seized by the Plant Quarantine Inspectors appointed by the Director of Agriculture, who shall order the immediate exportation of such plants or their immediate complete destruction according to the decision of the Director of Agriculture.

SEC. 3. Any person or persons who shall fail to comply with the requirements of this order shall be liable to the penalty provided in section 2746 of the Administrative Code of 1917.

(Sgd.) ADN. HERNANDEZ,
Director of Agriculture.

Approved:
(Sgd.) G. APACIBLE,
Secretary of Agriculture and Natural Resources.

REGULATIONS GOVERNING THE IMPORTATION OF FRUITS FROM COUNTRIES INFESTED WITH THE MEDITERRANEAN FRUIT FLY (*CERATITIS CAPITATA*)

MANILA, *July 16, 1920.*

ADMINISTRATIVE ORDER
No. 7.

Whereas, there is known to exist in the Hawaiian Islands, Spain, France, Southern Italy, Sicily, Greece, Malta, Asiatic Turkey, Egypt, Cape Colony, Natal, British East Africa, Madagascar, Brazil, Argentina, and the northern states of Australia, an insect known as the Mediterranean fruit fly, *Ceratitis capitata,* which affects among other fruits the mango, orange, banana, strawberry, carambola, bell pepper, papaya, carissa, sapote, lemon, coffee berry, persimmon, loquat, fig, mangosteen, tomato, alligator pear and guava; and

Whereas, this injurious insect has not yet appeared in the Philippine Islands; and

Whereas, such fruits as named above constitute an important part of the food of the Philippine Islands and any injury resulting to them would affect not only fruit growers but consumers as well; and

Whereas, the above injurious insect known commonly as the Mediterranean fruit fly totally destroys any fruit which it may enter;

Therefore, by authority of section 1756 of the Administrative Code of 1917, the following considerations shall regulate the importation of fruits and vegetables from the above countries into the Philippine Islands:

SECTION 1. The importation of all fruits of the species listed herewith is strictly prohibited from Spain, France, Italy, Sicily, Greece, Malta, Asiatic Turkey, Egypt, Tunis, Algeria, Cape Colony, Natal, British East Africa, Madagascar, Brazil, Argentina, the Bermuda Islands, the Hawaiian Islands and Australasia with the exception of the States of Tasmania, South Australia and Victoria in Australia. Importation from these last mentioned states may be allowed, provided that with each shipment a certificate be furnished from a properly authorized official of the Australian Government guaranteeing that such shipments originally emanated from the non-infested states of Tasmania, South Australia, and Victoria, that such shipments have not passed through any infested states and such a certificate shall give the last date of inspection of such non-infested regions. Fruits from these last mentioned states accompanied by such a certificate will be subject to inspection for other injurious insects and parasitic fungi before being admitted. Fruits from non-infested countries will similarly be admitted subject to inspection for other injurious insects and parasitic fungi.

SEC. 2. Any importation of fruits of the foregoing species in contravention of the provisions of this order shall be seized by the Plant Quarantine Inspectors appointed by the Director of Agriculture, who shall order the immediate exportation of such fruits or their immediate destruction according to the decision of the Director of Agriculture.

SEC. 3. Importations of fruits or seeds of the foregoing species from the quarantined countries may be made for promoting the fruit growing industry in this country; Provided, that such importations be made in small amounts and through the Director of Agriculture, who will have such plants or seeds isolated under quarantine until they have been shown to be free from all injurious insects and parasitic fungi.

SEC. 4. Any person or persons who shall fail to comply with the requirements of this order shall be liable to the penalties provided in section 2746 of the Administrative Code of 1917.

(Sgd.) ADN. HERNANDEZ,
Director of Agriculture.

Approved:

(Sgd.) G. APACIBLE,
Secretary of Agriculture and Natural Resources.

LIST OF FRUITS PROHIBITED FROM ENTRY UNDER SECTION 1. ADMINISTRATIVE ORDER No. 7

1. Sapodilla (Achras sapota)
2. Acordia (Acordia sp.)
3. Sour sop (Anona muricata)
4. Sugar palm (Arengia saccharifera)
5. Breadfruit (Artocarpus incisa)
6. Carambola (Averrhoa carambola)
7. Ball kamani (Calophyllum inophyllum)
8. Bell pepper (Capsicum sp.)
9. Papaya (Carica papaya)
10. Dwarf papaya (Carica quercifolia)
11. Carisa (Carissa arduina)
12. Sapota (Casimoroa edulis)
13. Chinese inkberry (Cestrum sp.)
14. Star apple (Chrysophyllum cainito)
15. Damson plum (Chrysophyllum oliviforme)
16. Chinese orange (Citrus japonica)
17. Kumquat (Citrus japonica)
18. Tangerine (Citrus nobilis)
19. Mandarin (Citrus nobilis)
20. Lime (Citrus medica limetta)
21. Lemon (Citrus medica limonum)
22. Grapefruit (Citrus decumana)
23. Shaddock (Citrus decumana)
24. Orange (Citrus aurantium)
25. Sour orange (Citrus aurantium var. amara)
26. Wampi (Clausena wampi)
27. Coffee (Coffea arabica)
28. Liberian coffee (Coffea liberica)
29. Quince (Cydonia vulgaris)
30. Persimmon (Diospyrus decandra)
31. Loquat (Eriobotrya japonica)
32. Brazilian plum or Spanish cherry (Eugenia brasiliensis)
33. Rose apple (Eugenia jambos)
34. Burinam cherry (Eugenia michelii)
35. French cherry (Eugenia uniflora)
36. Fig (Ficus carica)
37. Mangosteen (Garcinia mangostana)
38. Mangosteen (Garcinia xanthochymus)
39. Cultivated cotton (Gossypium spp.)
40. Mountain apple (Jambosa malaccensis)
41. Palm (Lantanis plucuachulla)
42. Tomato (Lycopersicum esculentum)
43. Lichee nut (Litchi chinensis)
44. Mango (Mangifera indica)
45. Elengi tree (Mimusops elengi)

46. Mock orange (Murraya exotica)
47. Banana (Musa spp.)
48. Noronhia (Noronhia emarginata)
49. Ochrosia (Ochrosia elliptica)
50. Prickly pear (Opuntia vulgaris)
51. Passion vine (Passiflora sp.)
52. Avocado (Persea americana)
53. Date palm (Phoenix dactylifera)
54. Strawberry guava (Psidium catteyanum)
55. Sweet red and white lemon guavas (Psidium guayava)
56. Common guava (Psidium guayava pomiferum)
57. Waiawi (Psidium guayava pyriferum)
58. Peach (Prunus persica)
59. Nectarines (Prunus persica var. nectarina)
60. Apricot (Prunus armeniaca)
61. Plum (Prunus spp.)
62. Pomegranate (Punica granatum)
63. Apple (Pyrus spp.)
64. Pear (Pyrus spp.)
65. Sandalwood (Santalum freycinetianum var. littorale)
66. Eggplant (Solanum melongena)
67. Wi (Spondias dulcis)
68. Natal plum (Terminalia chebula)
69. Tropical almond or winged kamani (Terminalia catappa)
70. Bestill (Thevetia nerrifolia)
71. Grape (Vitis labrusca)

THE SEASON'S EXPERIMENTS ON FIJI DISEASE,[1] MOSAIC DISEASE AND SMUT OF SUGAR CANE

By H. ATHERTON LEE, *Mycologist, Bureau of Science,* and MARIANO G. MEDALLA, *Assistant Pathologist, Bureau of Agriculture*

The experiments upon these diseases in the past season have been in the main demonstration and corroborative tests rather than actual research, altho such tests at the same time have served to orient our knowledge. It seems desirable to place the results on record, to make them available at the present time to planters in the Philippines.

FIELD EXPERIMENTS ON FIJI DISEASE AT CANLUBANG

Experiments were first layed out (1) to determine the losses due to the disease, (2) to determine the extent of reproduction of the disease by the use of cane points from affected plants, (3) to determine the relation of physical soil conditions to the disease and (4) to obtain information if possible on the aërial methods of transmission of the disease.

Experiment 1, plat 1, consisted of 8 rows, each of which was planted with cane cuttings from healthy stools alternating with cane cuttings from stools affected with Fiji disease. The planting was made with the Luzon White variety on February 19, 1921.

Observations on the resulting plants were made three months later on May 18 and again October 11, about eight months after planting. The cane was cut in early November so that further observations were not possible. The observations in detail are shown in figure 1.

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[1] In the experiments on Fiji disease we have had the close coöperation and advice of Prof. Colin G. Welles, of the Plant Pathology Department, College of Agriculture, University of the Philippines. We wish to acknowledge our appreciation to Professor Welles.

PLATE I

(See legend on list of illustrations)

Observation 3 months after planting

Row	H	F	H	F	H	F	H	F	H	F	H	F	H	F	H	F	H	F	H	F
1	h	f	h	h	h	----	----	----	h	f	h	----	h	f	h	----	h	f	h	f
2	[a]m	----	h	f	h	----	h	----	h	f	h	f	h	f	m	----	h	f	h	f
3	m	----	h	----	m	----	m	----	m	f	h	----	m	f	----	h	----	h	h	f
4	h	f	h	f	h	f	m	f	h	----	h	h	----	h	f	h	h	f	----	f
5	----	f	h	h	h	----	h	h	f	----	h	----	----	h	----	f	f	----	h	h
6	h	f	m	----	m	----	h	----	h	----	f	f	h	f	h	f	f	----	h	h
7	h	f	h	f	h	f	m	----	h	----	h	----	h	----	h	f	h	f	h	f
8	m	h	m	f	m	----	h	----	h	f	h	----	h	----	h	----	h	h	----	f

Observation 8 months after planting

Row	H	F	H	F	H	F	H	F	H	F	H	F	H	F	H	F	H	F	H	F
1	h	f	h	----	h	----	h	----	----	----	h	----	h	----	h	----	h	----	h	f
2	h	----	h	----	h	----	h	----	m	f	h	----	m	f	m	----	m	----	m	----
3	h	----	h	----	m	----	m	----	m	----	m	----	m	----	m	----	m	----	m	f
4	m	----	h	----	m	----	m	f	h	----	h	----	m	----	----	----	h	----	----	----
5	h	f	----	----	h	----	[a]s	----	----	----	h	----	h	----	h	----	----	----	h	----
6	m	----	m	----	----	f	m	----	----	----	f	----	----	----	h	----	----	----	h	----
7	m	----	m	f	m	----	h	----	m	----	m	----	h	f	m	----	m	f	h	----
8	m	----	m	----	m	----	m	----	h	----	m	----	m	----	m	----	h	----	----	----

h indicates a healthy stool.
f indicates stool affected with Fiji disease.
m indicates stool affected with mosaic disease.
s indicates stool affected with smut.

[a] For the purpose of determining data on Fiji disease, stools affected with smut or mosaic disease will be computed as healthy plants.

Figure 1.—Diagram of Experiment 1, plat 1, showing results of planting 8 rows containing 80 healthy points (H) alternating with 80 points from stools affected with Fiji disease, (F) Luzon White variety.

The results indicated in figure 1 may be summarized as follows in Table 1.

TABLE 1.—*Summary of the results of Experiment 1, plat 1, with Luzon White variety, planting points from healthy cane alternating with points from stools affected with Fiji disease*

	Germination		Diseased stools	
			May 18	Oct. 11
	Number	*Per cent*	*Per cent*	*Per cent*
From healthy points	71	88.75	7.03	[a]1.44
From diseased points	48	60.00	72.91	100.00

[a] The decrease in percentage of stools affected with Fiji disease is due to the dying of the stools affected earlier in the season.

The experiment was duplicated in plat 2 with the Cebu Purple variety and the results may be summarized as shown in Table 2.

TABLE 2.—*Summary of the results from Experiment 1, plat 2, with Cebu Purple variety, planting points from healthy cane alternating with points from stools affected with Fiji disease*

	Germination		Diseased stools	
			May 18	Oct. 11
	Number	*Per cent*	*Per cent*	*Per cent*
From healthy points	52	65.00	00.00	00.00
From diseased points	47	41.25	65.39	100.00

Observation 3 months after planting

Row																					Method of planting
1	f	f	f	f	f	------	------	f	------	f	------	f	f	f	f	------	f	f	f	------	Points from cane affected with Fiji disease.
2	------	------	------	------	------	------	f	------	f	f	f	------	------	------	------	------	------	f	f	f	
3	f	------	------	f	------	------	f	f	f	f	------	------	f	------	------	------	------	------	f	f	
4	h	------	h	h	------	h	h	------	------	------	h	h	h	h	h	------	h	h	h	h	Points from healthy cane.
5	h	------	------	h	h	------	------	h	h	h	m	h	------	------	h	------	------	------	------	h	
6	h	------	h	h	h	------	------	h	h	h	h	h	h	f	------	------	------	------	------	------	
7	f	------	------	------	------	------	f	------	------	f	------	f	f	f	------	------	f	f	f	f	Points from cane affected with Fiji disease.
8	------	------	------	f	f	f	f	------	f	------	f	f	------	f	f	f	f	f	------	h	
9	f	------	------	f	------	------	f	------	------	------	f	f	------	f	------	------	f	------	------	------	
10	h	m	h	h	h	h	h	h	h	------	------	------	h	------	h	h	h	f	------	------	Points from healthy cane.
11	------	h	h	h	h	h	h	h	h	------	------	h	h	h	h	------	------	h	------	------	
12	------	h	h	------	------	------	h	h	------	h	------	h	h	------	------	------	f	f	------	------	

Observation 8 months after planting

1	------	------	f	------	------	f	------	f	------	f	f	------	f	------	------	------	------	------	------	f	Points from cane affected with Fiji disease.
2	------	------	------	------	------	f	------	f	------	------	------	------	------	f	f	------	------	f	f	f	
3	------	------	------	------	------	------	f	f	f	------	------	------	------	------	------	------	------	f	------	------	
4	h	------	h	h	------	h	h	------	------	------	h	------	h	h	h	------	h	h	h	h	Points from healthy cane.
5	h	------	------	h	h	------	h	h	h	h	h	------	------	h	------	------	------	------	h	------	
6	------	m	------	h	h	h	------	h	h	h	h	h	h	f	------	------	------	------	------	------	
7	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	Points from cane affected with Fiji disease.
8	f	------	f	------	f	------	f	------	f	f	------	f	------	------	------	------	------	------	------	------	
9	------	------	------	------	------	------	f	------	------	------	------	------	------	------	------	------	------	------	------	------	
10	h	h	h	h	h	h	h	h	h	h	------	------	------	h	------	h	h	f	h	f	Points from healthy cane.
11	h	h	h	h	h	h	h	h	------	------	h	h	h	h	------	h	------	------	------	------	
12	h	h	------	------	------	h	h	------	h	------	h	h	------	------	------	------	------	f	------	------	

h indicates healthy cane stool. f indicates stool affected with Fiji disease. m indicates stool affected with mosaic disease.

Figure 2.—Diagram showing the results of planting points from cane affected with Fiji disease as compared with points from healthy cane, 3 months after planting and 8 months after planting; Luzon White variety.

PLATE I

(See legend on list of illustrations)

The stunted cane from diseased points alternating with the healthy cane from healthy points is shown in the photograph, Plate 1, which also shows the entire failure of affected stools to form cane.

Plats 3 and 4 of this experiment were intended to demonstrate more graphically to the planters the loss from the disease. In plat 3, six rows were planted entirely with points from stools affected with Fiji disease, while six rows adjacent were planted entirely with cuttings from healthy cane. The variety in this plat was Luzon White. The results are shown in figure 2.

The results shown in figure 2 may be summarized as follows in Table 3.

TABLE 3.—*Summary of the results of plat 3, Experiment 1, with Luzon White variety, planting points from healthy cane in rows for comparison with adjacent rows of cane points from stools affected with Fiji disease*

	Germination		Diseased stools	
			May 18	Oct. 11
	Number	*Per cent*	*Per cent*	*Per cent*
From healthy points	71	59.16	5.63	5.63
From diseased points	60	50.00	98.33	100.00

The experiment in plat 3 was duplicated with the Cebu Purple variety in plat 4. The results with this variety in plat 4 are summarized in Table 4.

TABLE 4.—*Summary of the results of plat 4, Experiment 1, with Cebu Purple variety, planting points from healthy cane in rows for comparison with adjacent rows of cane points from stools affected with Fiji disease*

	Germination		Diseased stools	
			May 18	Oct. 11
	Number	*Per cent*	*Per cent*	*Per cent*
From healthy points	66	55.00	0.00	0.00
From diseased points	47	39.16	78.72	92.85

The results in plats 3 and 4 were very striking and constituted an impressive demonstration of the losses resulting from Fiji disease. A photograph of the results in plat 4 is shown in Plate 2.

CONCLUSIONS

The apparent conclusions from these experiments are: (1) The germination of points from affected canes is much poorer than that of points from healthy stools; (2) the disease is transmitted by cane cuttings or, in other words, cuttings from an affected stool will result in a large proportion of cases in diseased stools; (3) the occurrence of the disease is not directly connected with any peculiar physical condition of the soil, but may be made to occur at will, in any type of soil, by using cuttings from affected plants; (4) cuttings from diseased stools result in a total loss, in that they either fail to germinate, or the resulting plants die shortly after germination, or the stools which ultimately survive yield no cane whatsoever. None of the affected plants in this experiment yielded any cane whatsoever; (5) the spread of the disease from affected plants to adjacent healthy plants was surprisingly low throughout the season, only 3.46 per cent of all points from plants from healthy stools becoming affected.

The results of these experiments should mean to cane planters that the losses experienced from Fiji disease are largely due to the use of points and cuttings from diseased stools and that such losses may be minimized by careful instruction to the seed cutters.

The experiments will continue and be enlarged upon during the coming year.

FIELD EXPERIMENTS ON MOSAIC DISEASE AT CANLUBANG

Experiment 2 of this series was intended to determine: (1) The extent of transmission of mosaic disease by points and cuttings; (2) the extent of losses on the native varieties due to this disease; and (3) to throw some light possibly on methods of transmission of the disease other than by cane points and cuttings.

Plats 1 and 3 of this experiment each consisted of 8 rows, each row being planted with cuttings obtained from healthy stools alternating with cuttings obtained from stools affected with mosaic disease.[1] The planting in plat 1 was made with the Luzon White variety on February 19, 1921.

The results are shown in the diagram following, figure 3.

Observation made 3 months after planting

Row	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M
1----------	h	----	----	----	h	m	----	----	h	m	f	----	h	m	h	m	h	m	h	m
2----------	----	----	h	m	h	m	h	m	h	m	h	m	h	m	----	m	h	m	h	m
3----------	h	m	----	----	m	m	h	[a]f	h	m	----	m	----	m	h	----	h	----	----	m
4----------	h	m	h	----	----	----	h	m	h	m	----	m	h	m	----	m	f	m	----	----
5----------	h	m	----	m	h	m	h	m	m	----	----	m	----	m	----	m	h	m	----	----
6----------	h	m	h	m	h	m	h	----	h	m	h	m	----	m	----	----	h	----	h	h
7----------	h	----	----	----	----	----	h	m	h	----	----	----	----	----	h	f	h	----	h	m
8----------	h	m	h	----	h	----	----	----	h	----	----	f	d	d	h	m	h	----	----	m

[a] Where Fiji disease occurs it is regarded as an undeterminable stool and does not enter into computations.

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[1] The idea of alternating the healthy with the diseased cuttings in the row is that of Dr. L. O. Kunkel of the experiment station, Hawaiian Sugar Planters' Association, who kindly consented to the repetition of this idea in experiments in the Philippines.

Same plat 8 months after planting

Row	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M	H	M
1	h	----	----	----	h	m	----	----	h	m	f	m	h	m	h	m	h	m	h	m
2	----	----	h	m	h	m	h	m	h	m	h	m	h	m	----	m	h	m	h	m
3	h	m	----	----	m	m	h	f	h	m	----	m	----	m	h	----	h	m	----	m
4	h	m	h	----	----	----	h	m	h	m	----	m	h	m	----	m	f	m	----	----
5	h	m	----	m	h	m	h	m	m	----	----	m	----	m	----	m	h	m	----	----
6	h	m	h	m	h	m	h	----	h	m	h	m	----	m	----	----	h	----	h	h
7	h	----	----	----	----	----	h	m	h	----	----	----	----	----	h	f	h	----	h	m
8	h	m	h	----	h	----	----	----	h	----	----	f	----	----	h	m	h	----	----	m

h indicates a healthy cane stool.
f indicates a stool affected with Fiji disease.
m indicates stool affected with mosaic disease.
d indicates a stool which is dead.

Figure 3.—Diagram of Experiment 2, plat 1, showing results of planting of 8 rows containing 80 healthy points (H) alternating with 80 mosaic points, (M) Luzon White variety.

These results may be summarized and shown in tabular form as in Table 5.

TABLE 5.—*Summary of the results of plat 1, Experiment 2, with Luzon White variety, planting points from healthy cane alternating with points from mosaic affected cane.*

	Germination		Diseased stools	
			May 18	Oct. 11
	Number	*Per cent*	*Per cent*	*Per cent*
From healthy points	53	66.25	3.93	3.93
From diseased points	51	63.75	97.91	98.00

The experiment was duplicated in plat 3 with the Cebu Purple variety and the results may be summarized as shown in Table 6.

TABLE 6.—*Showing the results from plat 3, Experiment 2, with Cebu Purple variety, planting points from healthy cane alternating with points from mosaic affected cane.*

	Germination		Diseased stools	
			May 18	Oct. 11
	Number	*Per cent*	*Per cent*	*Per cent*
From healthy points	60	75.00	6.45	1.47
From diseased points	48	60.00	84.74	100.00

Figure 3 and Tables 5 and 6 indicate the remarkably small amount of the spread of the disease to adjacent healthy stools under the conditions of the experiment.

Plats 2 and 4 of the experiment were intended to demonstrate more graphically to the planters the losses from the disease. In

Observation 3 months after planting

Row																					Method of planting
1	------	m	------	------	------	m	------	m	m	m	------	------	m	m	m	m	------	------	------	m	Points from cane affected with mosaic disease.
2	------	------	m	m	m	m	------	------	m	m	------	m	------	------	m	m	------	------	m	m	
3	------	m	------	------	m	m	m	------	m	------	------	m	m	------	------	m	m	m	m	m	
4	h	------	h	h	------	h	h	------	------	------	h	h	h	h	m	------	------	h	h	h	Points from healthy cane.
5	h	------	------	h	h	------	------	h	h	h	m	h	------	------	h	------	------	------	------	h	
6	h	------	h	h	h	------	------	h	h	h	h	h	h	f	------	------	------	------	------	------	
7	------	m	------	m	m	------	------	m	------	m	m	------	m	m	------	m	m	------	------	------	Points from cane affected with mosaic disease.
8	m	------	------	------	------	m	------	m	m	m	m	m	------	m	m	m	m	m	------	------	
9	m	m	m	------	m	------	m	------	m	------	------	m	m	m	m	m	m	m	------	------	
10	h	m	h	h	h	h	h	h	h	------	------	------	h	------	h	h	h	------	------	------	Points from healthy cane.
11	------	h	h	h	h	h	h	h	h	------	------	h	h	h	h	------	------	h	------	------	
12	------	h	h	------	------	------	h	h	------	h	------	h	h	------	------	------	f	f	------	------	

Observation 8 months after planting

Row																					Method of planting
1	------	------	------	------	m	------	m	m	------	------	------	m	f	m	m	m	------	------	------	m	Points from cane affected with mosaic disease.
2	------	m	m	m	m	------	------	m	m	------	m	------	------	m	m	------	m	------	f	------	
3	m	------	m	m	m	------	m	------	------	m	m	------	------	------	m	m	m	m	m	m	
4	h	------	h	h	------	h	h	------	------	------	h	------	h	h	h	------	h	h	h	h	Points from healthy cane.
5	h	------	------	h	h	------	h	h	h	h	h	------	------	h	------	------	------	------	h	------	
6	------	m	------	h	h	h	------	h	h	h	h	h	h	f	------	------	------	------	------	------	
7	m	------	m	------	m	m	------	------	------	m	------	m	m	------	m	m	------	m	m	m	Points from cane affected with mosaic disease.
8	m	m	------	------	------	------	m	------	m	m	m	m	------	m	------	m	m	m	m	m	
9	m	m	------	m	------	------	------	------	m	------	------	m	m	m	m	m	m	m	m	m	
10	h	h	h	h	h	h	h	h	h	h	------	------	------	h	------	f	h	h	h	f	Points from healthy cane.
11	h	h	h	h	h	h	h	h	------	------	h	h	h	h	------	h	------	------	------	------	
12	h	h	------	------	------	h	h	------	h	------	h	h	------	------	------	f	------	------	------	------	

h indicates a healthy cane stool. m indicates stool affected with mosaic disease. f indicates a stool affected with Fiji disease.

Figure 4.—Shows the results of planting points from cane affected with mosaic disease as compared with points from healthy cane, 3 months after planting and 8 months after planting; variety Luzon White.

plat 2 of this experiment, six rows were planted entirely with cuttings from stools affected with mosaic, while six rows adjacent were planted entirely with cuttings from healthy cane. The variety in this series was Luzon White. The results are shown in figure 4.

These results may be summarized and tabulated as follows in Table 7.

TABLE 7.—*Summary of the results of plat 2, Experiment 2, with Luzon White variety, planting points from healthy cane in comparison with points from mosaic affected cane*

	Germination		Diseased stools	
			May 18	Oct. 11
	Number	*Per cent*	*Per cent*	*Per cent*
From healthy points	69	57.50	4.54	1.49
From diseased points	68	56.66	100.00	100.00

This experiment in plat 2 with Luzon White variety was duplicated in every detail with the Cebu Purple variety in plat 4. The results from plat 4 may be summarized and tabulated as follows in Table 8.

TABLE 8.—*Summary of the results from plat 4, Experiment 2, with Cebu Purple variety, planting points from healthy cane in comparison with points from mosaic affected cane*

	Germination		Diseased stools	
			May 18	Oct. 11
	Number	*Per cent*	*Per cent*	*Per cent*
From healthy points	64	53.33	9.37	4.61
From diseased points	59	49.16	83.06	100.00

Mosaic diseased stools, even if affected when young, usually make some growth, and affected stools are consequently not a total loss. It was expected to make weighings from the different plats, therefore, in order to obtain definite data as to the amounts of the losses. The cane in the plats, however, unfortunately was cut before the completion of the experiment, so that such data were lost. During the growing season, however, the differences in size were very definite and are to some extent shown in the photograph in Plate 15 of this number of the Philippine Agricultural Review.

CONCLUSIONS

These experiments, mainly for the purpose of field demonstration, show: (1) That germination of cane points from stools affected with mosaic disease is usually slightly poorer than is that of points from healthy cane; (2) that the disease may be produced at will on any soil, irrespective of drought, by planting points from affected stools; (3) the experiments corroborate the findings in Java, Hawaii, and Porto Rico, that cane points and cuttings from diseased stools will reproduce the disease in a large percentage of the resulting plants, usually 100 per cent; (4) an unexpected result of considerable practical importance to the planter also is the very small amount of transmission of the disease from diseased to healthy stools during the past season, under the Canlubang conditions. Although these results seem to indicate that mosaic disease is perpetuated almost entirely by carelessness in selecting the seed, repeated experience under various seasonal conditions will be necessary to warrant the apparent conclusions from these experiments, that insect and other possible methods of aërial transmission are such minor factors in the disease transmission; (5) it is evident also that in the course of the season a small proportion of the plants may grow out of the disease to such an extent that the leaf symptoms are no longer visible.

FIELD EXPERIMENTS ON SUGAR CANE SMUT IN MANILA

Experiment 4 of this series was intended (1) to determine the extent of transmission of the disease by points and cuttings; (2) to indicate the loss due to smut to the planters; and (3) to determine possibly the extent of other means of transmission of the disease.

Because of the limited area of ground available, the experiment was necessarily on a small scale in Manila, altho it was repeated on a plantation scale at Canlubang. Because of its extreme susceptibility to cane smut, the Uba variety, which is grown extensively for forage, and to some extent for sugar production in Pampanga Province, was employed in this experiment.

Plat 1 of this experiment consisted of two rows, each planted with 12 cuttings from healthy cane. Plat 2 consisted of two rows, each row planted with 12 cuttings from diseased cane. Plat 3 consisted of two rows, in each row 6 cuttings from healthy cane being alternated with 6 cuttings from diseased cane. Plat 4 consisted of four rows planted with cuttings from healthy cane soaked in the same water and same receptacle with cuttings from diseased cane. All plantings were made on April 30, 1920. The first and last observations of the resulting plantings are shown as recorded in figure 5.

PLATE III

(See legend on list of illustrations)

Observation 1 month after planting

Plat 4	h	h	h	h	h	h	h	h	h	h	h	h	Points from healthy stools soaked with diseased points.
	h	h	h	h	h	h	h	h	h	h	h	h	
	h	h	h	h	h	h	h	h	h	h	h	h	
	h	h	h	h	h	h	h	h	h	h	h	h	
Plat 3	h	----	h	----	----	----	h	h	h	h	h	s	Healthy points alternating with diseased points.
	h	h	----	----	h	h	h	h	h	s	h	----	
Plat 2	s	----	----	----	----	s	----	h	h	----	h	----	Points from diseased cane.
	h	h	----	h	s	----	h	h	h	h	h	----	
Plat 1	h	h	h	h	h	h	h	h	h	h	h	h	Points from healthy cane.
	h	h	h	h	h	h	h	h	h	h	h	h	

Observation 6 months after planting

Plat 4	h	h	h	h	h	h	h	h	h	h	h	s	Points from healthy stools soaked with diseased points.
	h	h	h	h	h	h	h	s	s	h	h	h	
	s	h	h	h	h	h	h	h	h	h	h	h	
	h	h	h	h	h	h	h	h	h	h	h	h	
Plat 3	h	s	h	h	h	s	h	----	h	h	h	s	Healthy points alternating with diseased points.
	h	----	----	----	----	----	h	h	h	s	h	----	
Plat 2	s	----	----	----	----	----	s	s	s	----	s	----	Points from diseased cane.
	s	s	s	----	s	----	----	s	s	----	s	----	
Plat 1	s	h	h	h	h	h	h	h	h	h	h	h	Points from healthy cane.
	h	h	h	h	h	h	h	h	h	h	h	h	

h indicates a healthy stool. s indicates a stool affected with smut.

Figure 5.—Diagram of experiment 4 of sugar cane smut series, showing results of planting cuttings from stools affected with smut as compared with cuttings from healthy stools.

These results after 6 months, at the beginning of the dry season, may be summarized as follows in Table 9.

TABLE 9.—*Summary of the results of experiment 4 with Uba cane in Manila, planting points from healthy stools in comparison with points from smutted stools, and with points from healthy cane exposed to infection in the soaking process.*

	Germination		Smut affected stools	
			June 6	Nov. 3
	Number	*Per cent*	*Per cent*	*Per cent*
From healthy cuttings	35	97.22	0.00	2.94
From smut cuttings	21	58.33	23.80	84.21
From healthy cuttings soaked with smut cuttings	48	100.00	0.00	8.33

As a demonstration of the injury resulting from the use of cuttings from affected stools, this experiment was very effective. A photograph of the experiment is shown in Plate 3. There was no yield of cane from plat 2 as compared with a normal yield from the healthy cane, plat 1. The experiments will be carried over into the first ratoon crop.

The experiments at Canlubang consisted of four plats, two of which were planted entirely with cane points from stools affected with smut, while two plats lying adjacent were planted entirely with cane points from healthy stools. The results of the experiments may be summarized as follows in Table 10.

TABLE 10.—*Showing results of experiment 2 with Uba cane at Canlubang, planting points from healthy cane in comparison with points from cane affected with smut.*

	Germination		Smut affected stools		Number of stools, Oct. 11
			May 18	Oct. 11	
	Number	*Per cent*	*Per cent*	*Per cent*	
Points from healthy cane	99	61.87	0.00	0.00	98
Points from smutted cane	10	6.25	33.33	42.85	[a] 7

[a] There was no yield of cane whatsoever from these 7 stools, all growth being in the form of the whips characteristic in smutted cane.

CONCLUSIONS

These experiments show (1) that germination of cane points from stools affected with smut is decidedly poorer than is that of points from healthy cane; (2) points or cuttings from stools affected with smut reproduce the disease in a high proportion of cases; (3) there is no cane yield from planting points or cuttings from stools affected with smut; (4) in the six months duration of the experiments the spread of the disease into the healthy stools was very slight, only 0.75 per cent of the stools from healthy points showing the disease. These results are hardly representative, however, since it would have been more desirable to carry the experiments throughout the whole season; (5) points from healthy cane allowed to soak in the same receptacle with cane from smutted stools showed 8.33 per cent of the resulting cane plants to be affected. This is apparently one method of the spread of the disease.

The apparent conclusion for the cane planters who wish to continue to grow susceptible varieties is that selection of seed points only from healthy stools is essential in order to avoid loss of cane from cane smut.

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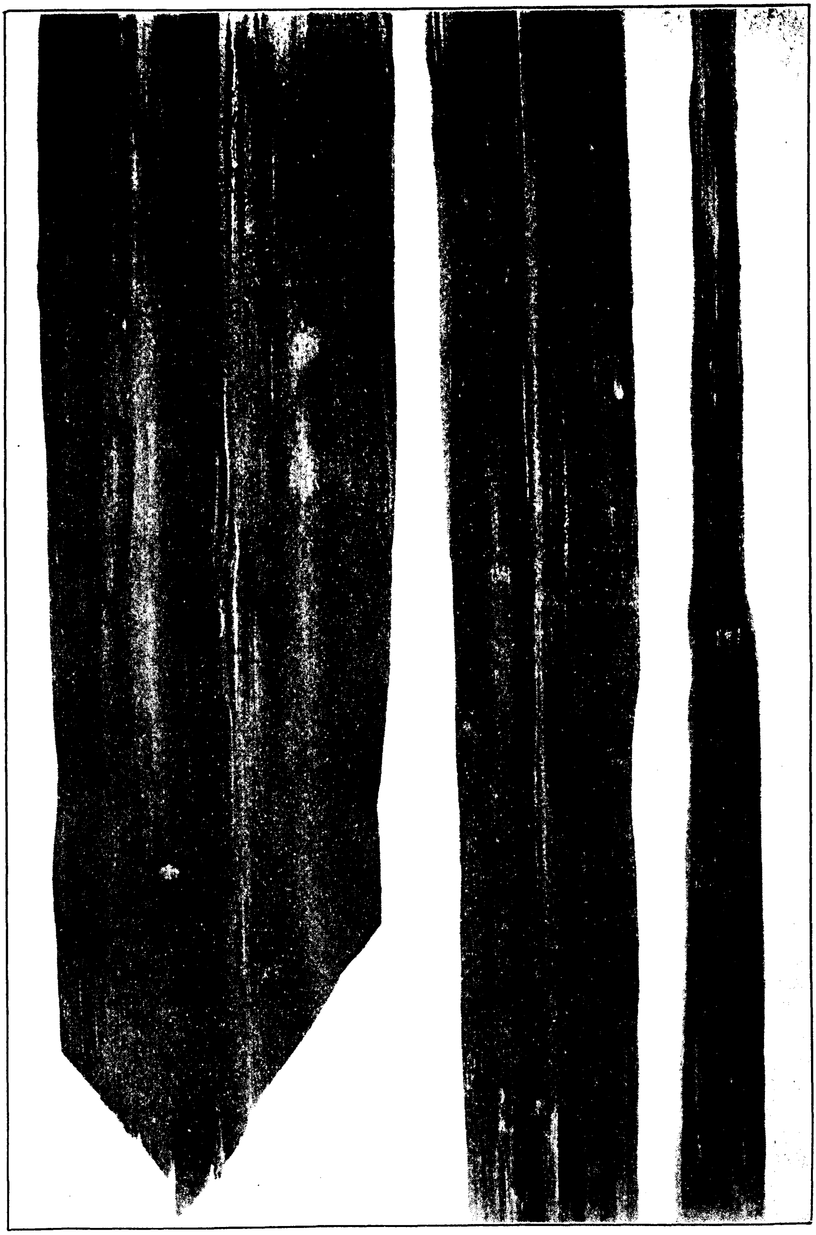

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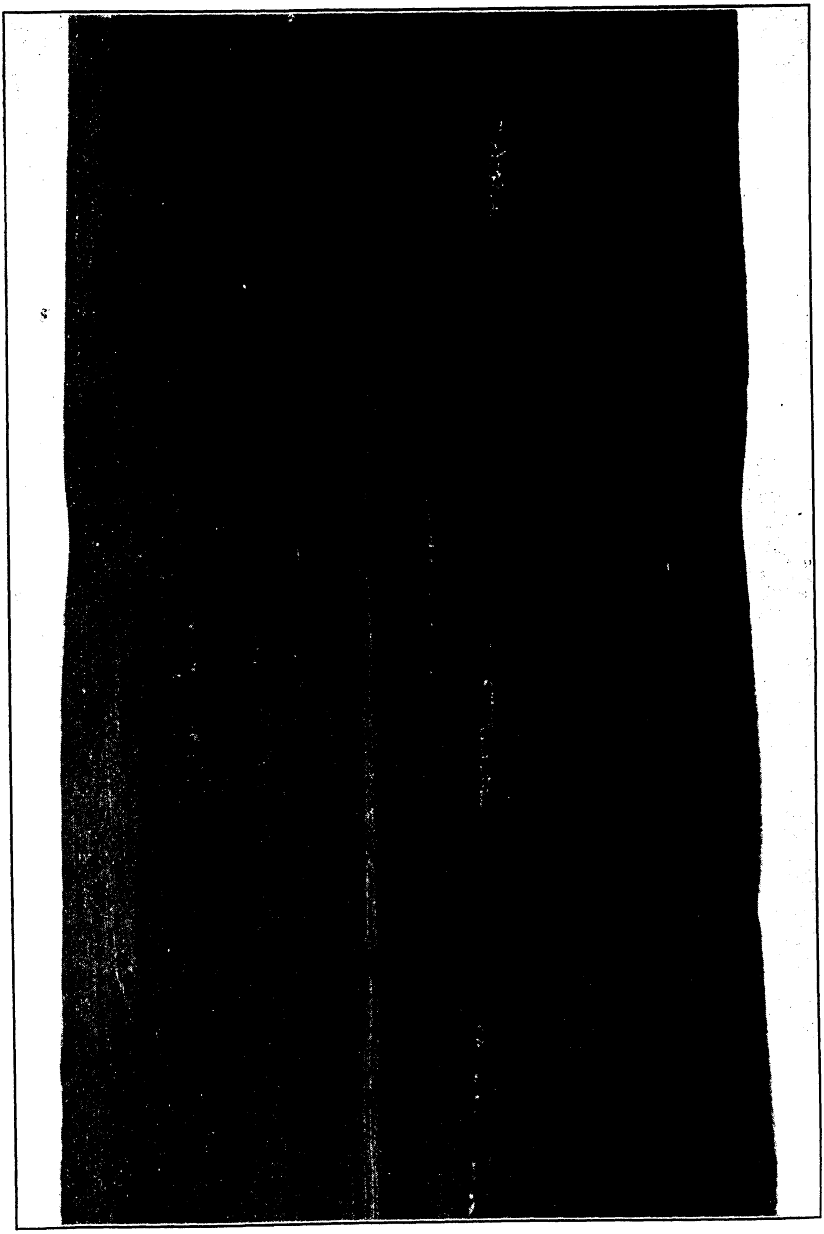

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FIJI DISEASE OF SUGAR CANE IN THE PHILIPPINES

By H. ATHERTON LEE, COLIN G. WELLES, AND MARIANO G. MEDALLA, *from the Bureau of Science, College of Agriculture, and Bureau of Agriculture, respectively.*

INTRODUCTION

The present publication is intended for the main purpose of acquainting the sugar planters of the Philippines with the appearance of Fiji disease of cane, its possibilities in decreasing the cane crop, and such knowledge as is available as to its cause, methods of transmission and prevention. Photographs are presented in detail to aid the planter in identifying the disease. Although the publication is primarily for the cane planters of this country, it is possible, inasmuch as Fiji disease is not known in many of the other cane growing countries, that these photographs and information may be of value in such other countries, aiding in the recognition, and maintenance of their fields free of the disease.

A large portion of the available knowledge concerning this disease is due to the studies of Dr. H. L. Lyon of the Experiment Station of the Hawaiian Sugar Planters' Association. Cane planters in the Philippines owe much to Dr. Lyon and the Hawaiian Sugar Planters' Association for the contributions to the knowledge of this disease.

HISTORY OF THE DISEASE

Fiji disease was made known to American cane growers by Mr. Muir of the Hawaiian Sugar Planters' Association in letters from Fiji published in the Hawaiian Sugar Planters' Record in 1910. The disease was subsequently found in New Guinea and Australia and is believed to have originated in New Guinea.

The disease was mentioned in the Philippines for the first time, in the Annual Report of the Director of Agriculture for 1919 and was said to be present in Mindoro. Professor Reinking apparently not aware of this report was of the opinion in the November 1920 Sugar News that Fiji disease was not present in the Philippines but this was a mistake as pointed out by Medalla and Reyes in the Philippine Farmer in January 1921. They reported their observations of the disease as observed at

Mindoro and also in Laguna and Batangas Provinces. Reinking in a later article reported his finding the disease in the Philippines, corroborating the report of the Director of Agriculture and the findings of Medalla and Reyes.

In 1920, a survey of the cane fields of the south of Occidental Negros showed no Fiji disease present. In September, 1921, Lee and Kopke found Fiji disease well distributed throughout northern Negros, but apparently not of long duration in that region. The disease is apparently spreading from north to south rapidly. In August, 1921, specimens were received from Mr. Eustacio Villanueva in Zamboanga, Island of Mindanao, which were identified by the senior writer as Fiji disease. It apparently is not yet widely distributed in Mindanao.

It is apparent that Fiji disease has a strong foothold and a fairly wide distribution in the Philippines. Circumstantial evidence would point to the introduction of the disease into this country on cane cuttings from Australia or the other countries affected.

DESCRIPTION OF THE DISEASE

The gross effects of the disease are a stunting of affected stools of susceptible varieties; such stunting is shown in the photographs in Plates 4 and 5. The cane has much the appearance of a stool the top of which has been bitten off by a horse or carabao or other animal. There is also an abnormal production of shoots from the upper eyes of an affected cane, which give a bunchy appearance, shown in Plate 6. Closer examination shows the leaves to be stunted, usually shorter and blunter than normal leaves, and in old cases much narrower. Always associated with Fiji disease, are small elongated galls running longitudinally with the leaf, usually on the under surfaces. Usually these galls are more numerous on the lower portion of a leaf nearest the cane than towards the tip. The galls may be infinitesimal in size or as large as several centimeters in length. Such galls are shown in Plates 7 and 8. The galls are not always present in new cases but are always found in well developed cases; their presence indicates very definitely the presence of Fiji disease. A well infected cane is brittle and breaks much more readily than a healthy cane. The appearance of the disease is best obtained by individual demonstration, although the photographs accompanying this brief description will aid considerably in the identification.

THE CAUSE OF THE DISEASE

Many theories have been ascribed by growers as the cause of the disease, among them poor soil conditions, poor aëration of

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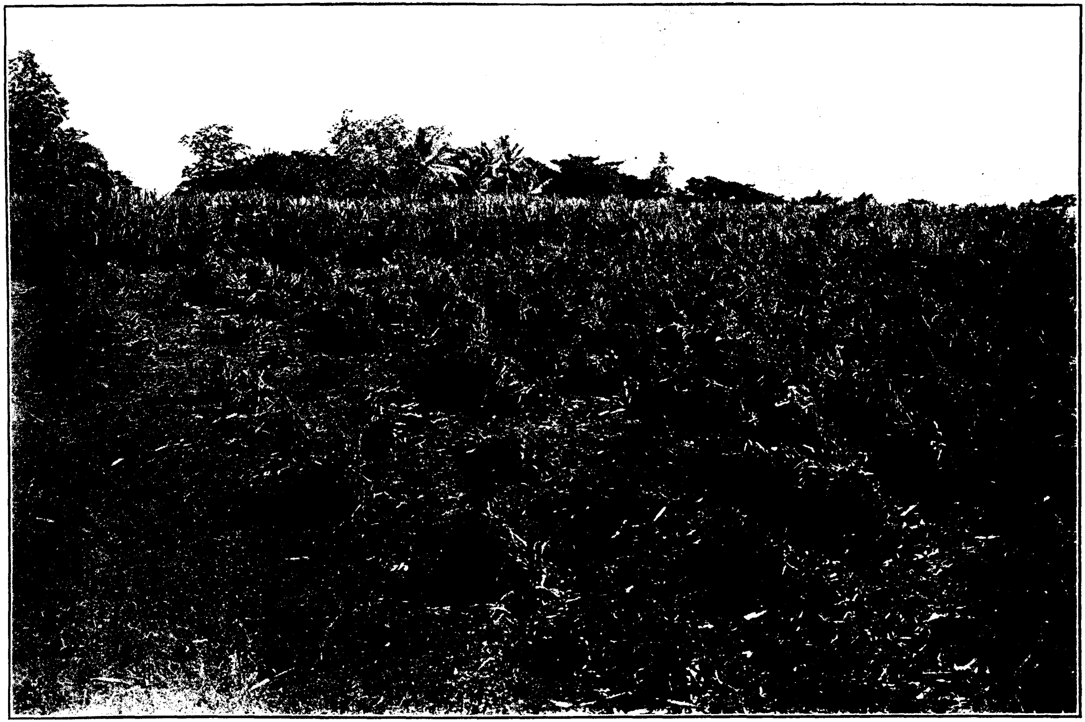
PLATE X

(See legend on list of illustrations)



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the soil, gravel underneath affected plants, too much humus, too little humus, and similar opinions. These theories are all rather definitely disproven by our experiments which have shown that the disease will occur in any type of soil, if affected cane points are planted, while if healthy cuttings are planted alongside the affected ones in identical soil, they will come up healthy.

Dr. Lyon was the first to point out the presence of small bodies in the galls of the disease; these bodies are regarded as forms of a microscopic organism, a fungus somewhat similar to what is known as *Plasmodiophora brassicae*. By comparison with other completely proven diseases, the indications are very strong that these are living parasitic bodies and with a very intimate connection with the disease. Other than these bodies as living parasitic organisms, there is no plausible theory explaining the disease. Investigations are at present being carried on which will add to the understanding of the cause of the disease.

Field evidence in Negros very strongly indicates transmission of the disease from plant to plant, although the agent or carrier of the infection is not definitely known. Methods for aërial transmission might be wind, rain, insects, birds or some such agency.

In addition to aërial infection, it is clearly demonstrated that the disease is transmitted by cane cuttings taken from an affected stool. In other words, cane points from an infected plant will reproduce diseased stools. This has been described in detail in another paper.

LOSSES DUE TO THE DISEASE

It is desirable that cane planters should have a clear understanding of the nature of losses due to diseases. The history of plant diseases shows only a very few devastating diseases; on the other hand, there are hundreds of less noticeable diseases which, although they do not entirely destroy the crop, reduce by a small percentage the normal yield of crops. Fiji disease is in many cases a devastating disease; a stool of cane affected with the disease is a total loss. There is a very prompt cessation of growth when a stool is affected; a young stool when affected forms no cane whatsoever but becomes a bunch of numerous small shoots like a clump of grass. There are instances where entire fields have been entirely destroyed due to Fiji disease, causing not only a total loss of cane, but the total loss of all labor and capital invested in preparing the land. The effects of Fiji disease may be judged from the photographs in Plates 5, 9, 10, and 11.

Commonly, however, Fiji disease does not attack all stools and therefore does not entirely destroy all the crop; the yield is reduced according to the number of stools attacked. One plantation manager has estimated losses due to this disease on his plantation to amount to 25 per cent. Even were this estimate to be exaggerated, the loss if but one half of the estimate would be 12 per cent. Another instance may be cited; although Negros is apparently a newly infected province, in a field there, an actual count revealed a complete loss of 10⅔ per cent of the stools. These losses are just as tangible in the field as in the warehouse. In average years, a yield on a planter's investment is not much greater than 10 per cent, often less than that. In other words, such a disease may create the difference between profit on the year's crop, and loss.

Another cause of loss from the disease is the prevention of ratooning. It is very difficult to raise ratoon crops in the presence of this disease by the methods at present in vogue.

Cane production is a highly organized industry, probably as much so as any agricultural industry. Competition between sugar producing countries is now very keen. Any country whose sugar industry is throwing away 10 to 25 per cent of their output, must either be eliminated from the competition or make up their losses by exploiting their labor. The latter course is not advantageous to the country.

These statements apply not only to losses due to Fiji disease, but to losses from other diseases, such as cane mosaic, cane smut and insect injuries, such as top borer. These diseases should be minimized if the Philippine industry is to compete with countries such as Hawaii, Cuba, Porto Rico, and Argentina, which, in many cases, do not have these diseases or else are controlling them.

METHODS OF REDUCING THE LOSSES FROM FIJI DISEASE

(1) Fiji disease is transmitted from crop to crop, largely by cuttings taken from affected plants. It is obvious that by selecting cane points from healthy stools the disease will be very largely minimized. It is essential in such a campaign that every hacendero familiarize himself with the disease, and then carefully instruct his cane cutters in the symptoms of the disease. Only by careful instruction can the work of seed selection be accomplished, yet such careful instruction is one of the highest yielding investments in Philippine cane fields.

(2) There is some variation in the susceptibility of cane varieties to this disease. Badilla cane in the experience of Dr. Lyon, and in our experience, is less susceptible than many of the other varieties. It has the advantage moreover that when affected, the symptoms of the disease are obvious and cane cutters are thus very much aided in discarding affected cane points. Badilla cane is one of the most widely planted canes in Australia and its acreage is also being very greatly increased in Hawaii. As a sugar producer, it is an apparently better cane than the Negros Purple cane, now generally planted in Negros. Work is being continued to find other resistant varieties.

(3) Hacenderos who do not have the disease as yet should plant only from cane points from their own fields or from fields of other hacenderos where there is no disease.

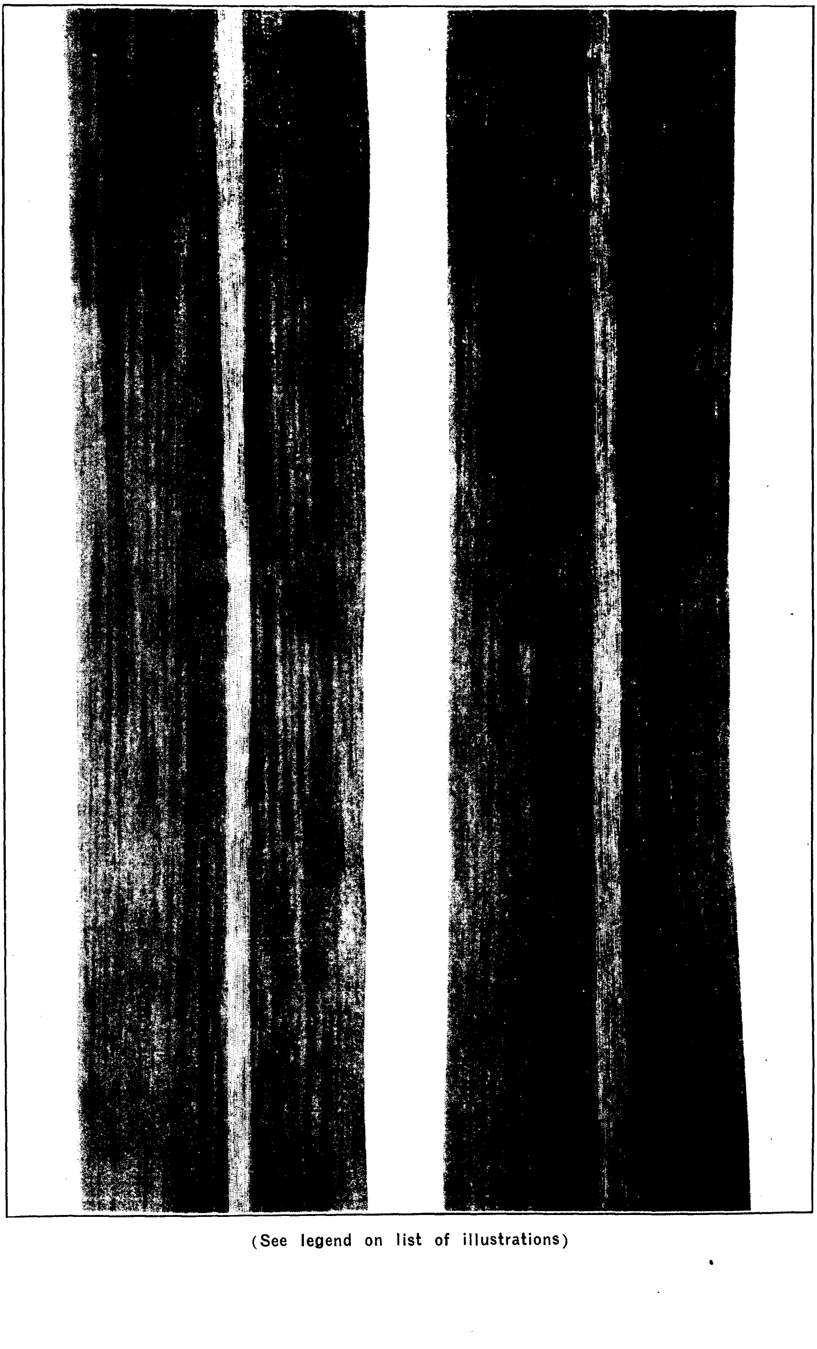
MOSAIC DISEASE OF SUGAR CANE IN THE PHILIPPINES

By H. ATHERTON LEE and E. W. KOPKE
Of the Bureau of Science and Philippine Sugar Centrals Agency, respectively

The present publication is intended to describe and illustrate the disease of sugar cane known as mosaic or yellow stripe so that cane planters may easily recognize it. Data are also given to show the distribution, losses due to this disease in the Philippines, and such measures as may aid in its prevention.

HISTORY OF THE DISEASE

Yellow stripe or mosaic was first described from Java some fifteen or twenty years ago. A number of valuable publications concerning this disease have also emanated from the Hawaiian Islands since 1911. In 1915 a disease appeared in Porto Rico which became known as mosaic disease and which Dr. H. L. Lyon of the Sugar Planters' Experiment Station in Honolulu, later showed to be identical with the yellow stripe disease of Java and Hawaii. The disease is now known also from Argentina, Fiji, Australia, New Guinea, Cuba, Egypt, and Louisiana. The first observation of yellow stripe disease in the Philippines was made by Dr. H. L. Lyon in his visit here about 1910 or 1911. Mention of the disease in the Philippines is also made in a quotation from Dr. Lyon in the Annual Report of the Insular Experiment Station of Porto Rico for 1919. Reinking in the December 1920 Sugar News apparently was not aware of the presence of the disease or of the literature since he advised against the importation of the disease. Lee and Medalla announced the presence of yellow stripe or mosaic disease in Rizal, Laguna, and Batangas Provinces in October, 1920; it was rather common in these provinces. Cases of the disease have been observed in Bulacan and Pampanga, but it is much less common there at the present time, although it is probably spreading. Lee and Kopke in the Sugar News for December, 1921, described the presence of mosaic disease very commonly throughout the Binalbagan, Isabela and La Carlota and Maao districts of Occidental Negros. Although it was much more rare at



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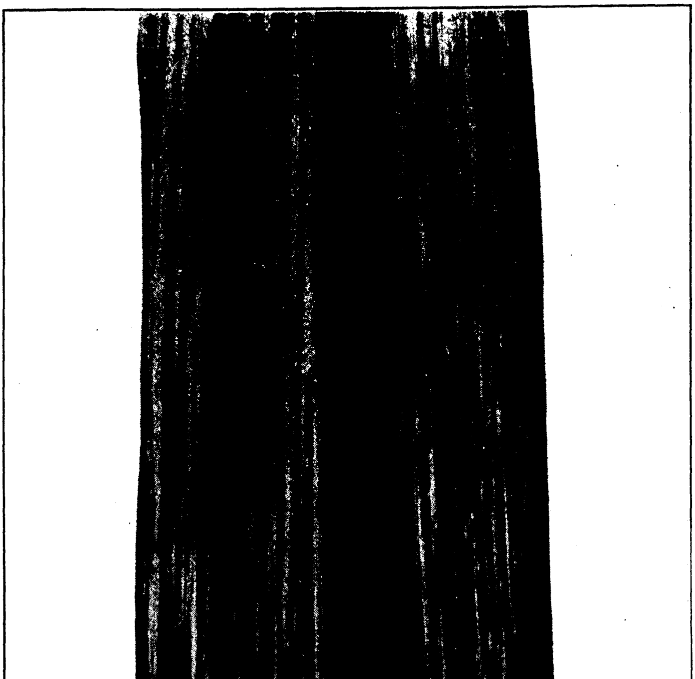

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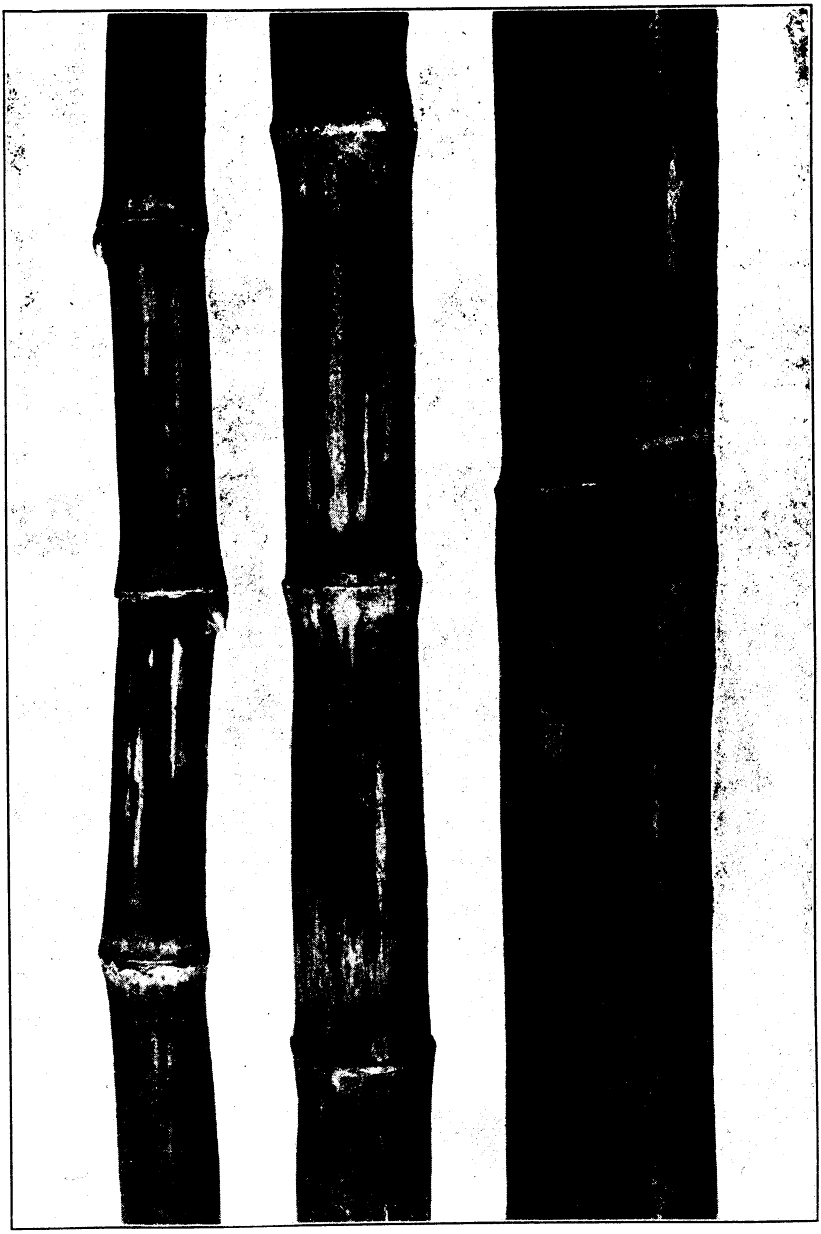

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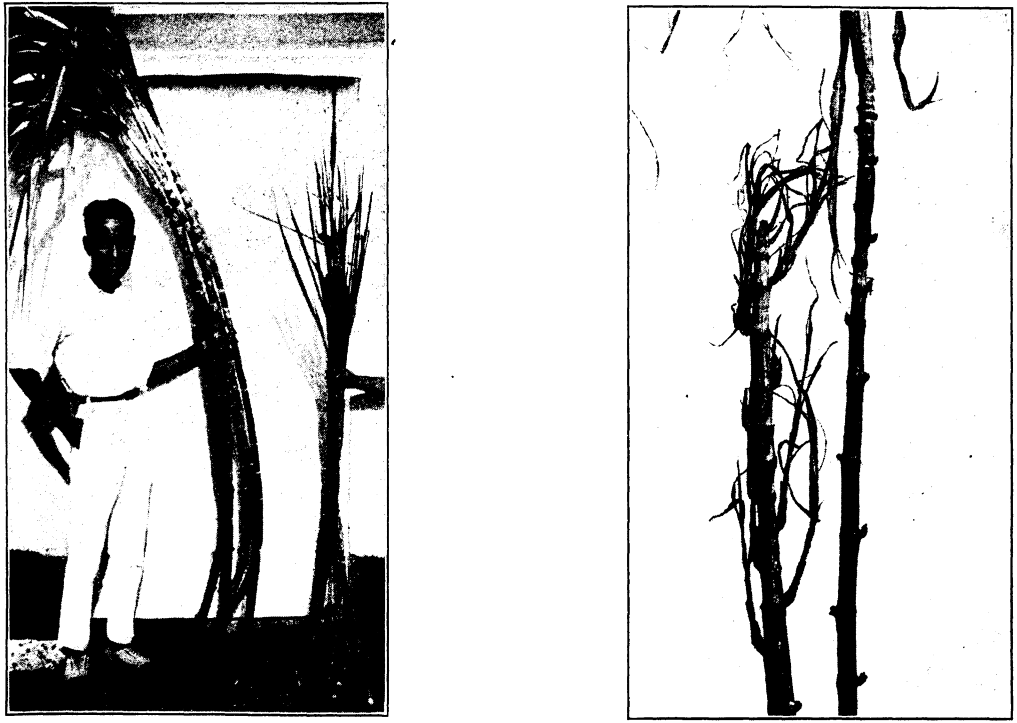

(*a*)

(*b*)

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Bacolod, Talisay, and Silay, it is probably spreading there gradually at the present time. No cases of the disease were observed at Victorias, Manapla, or Cadiz at that time.

DESCRIPTION OF THE DISEASE

As with other plant diseases an individual demonstration in the field can acquaint a cane grower with this disease in a few minutes, whereas with a written description it is much more difficult to achieve results.

Mosaic disease is most readily recognized by a pattern upon the leaves of affected plants. This pattern consists of yellow or pale green blotches or irregular streaks distributed throughout the normal green of the leaf. The blotches are more often pale green than yellow and in many cases only close observation can distinguish these pale areas on the leaf. Plates 12 and 13 illustrate the appearance of this disease on Cebu Purple and Louisiana Striped varieties.

On badly affected plants symptoms are also exhibited on the cane itself. On yellow varieties a mottling or streaking with a green or pinkish color will be apparent; on purple varieties a mottling with yellowish or grayish white streaks. Such effects on the cane are shown in Plate 14.

The effect of the disease as a whole upon the cane is to give it a yellowed appearance. An affected field in a district of normally growing cane can be distinguished at a considerable distance by its yellowed appearance. In very few cases are affected canes completely killed; the effect of the disease is to stunt the cane. This is shown in Plate 15. Not only is the length of the cane affected but the diameter of cane is much reduced by the disease. This is shown in Plates 14 and 16(*a*). The whole effect is to cut down the yield of the cane and in that way cut down the yield of sugar. In a few cases, on very susceptible varieties, growth of the cane is entirely stopped; such canes are shown on Yellow Caledonia cane in Plate 16(*b*).

The disease seems to be cumulative and in our experience increases with each ratoon crop.

KNOWLEDGE CONCERNING THE CAUSE OF THE DISEASE

It has been shown by experiments in the United States that aphids reared on healthy cane, placed on mosaic cane, and then placed again upon healthy cane will transmit the disease from the affected to the healthy cane. In other words, mosaic disease has been shown to be infectious by means of insect carriers.

It has also been shown in Java, Hawaii, the United States and, later, here in the Philippines that seed points taken from affected plants will give rise to affected plants, while under identical soil and climatic conditions seed points from healthy canes will give rise to perfectly healthy stools. The disease then is transmitted from crop to crop by cane points as well as possibly by insects.

As to the infectious agent, although much work has been done in Java, Hawaii, and the United States in attempts to discover the nature of such an agent, such work has so far failed to reveal an organism connected with the disease. Nevertheless, with constantly improving methods and application, it is probable that the infectious agent will soon be recognized and even isolated.

LOSSES DUE TO THE DISEASE

As pointed out previously, it is only in very rare cases that mosaic disease entirely kills the cane. The effect of the disease is to lessen the growth of the cane; such effects are exhibited differently on the several cane varieties. For instance, the stunting of the variety D-1135 by this disease is very slight; the stunting of the variety Cebu Purple is rather marked; while such varieties as H-109 and Yellow Caledonia are severely stunted. Yellow Caledonia, in our experience, has the peculiarity, however, of being not commonly infected in the field; when it is infected, however, the stunting is very pronounced.

Losses on Cebu Purple variety here in the Philippines may amount to 20 per cent. Doctor Lyon has shown in Hawaii that losses may vary from 0.5 per cent to as high as 46 per cent, depending on the variety. Work is being continued to determine more carefully the amounts of loss in this country.

CONTROL OF THE DISEASE

The disease is being perpetuated in the Philippines by the failure of cane cutters to recognize it and, consequently, by the use of cane points from affected canes. Such cane points result in stools of cane affected with mosaic disease, which then serve as sources for the dissemination of this disease by insect carriers to the other healthy cane stools. It is obvious then that the first step in the prevention of the disease is to select cane points from healthy stools only, and avoid those affected with mosaic disease. This measure will therefore depend upon careful instruction to seed cutters. By the enforcement of this measure alone the disease may be very much minimized.

A few hacenderos, however, will find themselves with no healthy stools available, their whole fields being affected with mosaic disease. Such planters should buy cane points from hacenderos whose fields are entirely free from the disease.

As previously mentioned, there are wide differences among varieties in regard to susceptibility. Hacenderos may plant the variety D-1135, and even Yellow Caledonia, if the points of such varieties come from fields of unaffected cane, and feel assured that the spread of mosaic disease into such varieties will be slight, or at least slow. The Japanese forage canes known as Uba, Zwinga, etc., are immune to the disease; although very poor sugar producers, they have been used for sugar production in Porto Rico to some extent because of their immunity. It does not seem necessary at present, however, for Philippine planters to resort to such Japanese forage varieties.

OBSERVATIONS ON PREVIOUSLY UNREPORTED OR NOTEWORTHY PLANT DISEASES IN THE PHILIPPINES

By H. ATHERTON LEE
Mycologist, Bureau of Science

It is necessary, in preventing the introduction and spread of plant diseases by plant quarantine regulations, to have an exact knowledge of the occurrence and distribution of the diseases already in the Philippines. The study of plant diseases having been so recently organized here, very little information as to the occurrence and extent of these troubles has been available. However, some knowledge has been accumulating which it seems advisable to place on record at this time. This paper does not make any pretense of giving a detailed description or the methods of control of these diseases; only a very slight amount of detailed data on such control methods is available at the present time.

The information of the occurrence of these diseases in several cases may be of interest also to students of plant diseases in other countries.

CITRUS DISEASES

Psorosis or California scaly back.—This disease, the cause of which is as yet unknown, occurs upon trees of the sweet orange, *Citrus sinensis*, thruout Laguna, Batangas, and Rizal Provinces, and has also been observed in Basilan and Davao. It is apparently of long duration in the Philippines and is the cause of a great deal of loss to the growers of sweet oranges. It has not previously been reported here.

Florida scaly bark or nail head rust.—This disease has been found in Batangas Province upon trees of the sweet orange, *Citrus sinensis*, but does very little injury. It has not been observed in the southern islands yet, altho observations there have been limited. This is the first report of the disease from this country.

Foot rot.—This disease, reported to be due to the fungus *Phytophthora terrestria*, has been observed in Bataan, Laguna,

PLATE XVII

(See legend on list of illustrations)

and Batangas Provinces. Next to psorosis, it is probably the worst disease of citrus trees in oriental countries. It has been observed most seriously on seedling trees of the sweet orange and trees budded upon sweet orange stock.

Bark rot.—This disease, the cause of which is as yet unknown, has been observed upon trees of the Mandarin orange, *Citrus nobilis.* It is very serious in the Philippines, ranking next to psorosis and foot rot in importance. There is evidence which would indicate that bark rot is an introduced disease from China, being brought in here probably since the days of American occupation.

Altho the opportunity has never been permitted of carrying on spraying experiments against this disease particularly, some interesting results were apparent after a series of spraying experiments intended primarily for the prevention of citrus canker. One year after the conclusion of the citrus canker experiments at Lamao, Bataan, bark rot was found affecting six trees distributed in our three unsprayed plats. Not a single case of bark rot could be found in the five plats which had been sprayed with fungicides. These results, altho not constituting careful experimental data, nevertheless are an indication that spraying would prevent or minimize the disease. The injury resulting from bark rot is shown in the photograph, Plate 17.

Pink disease.—This disease caused by the fungus, *Corticium salmonicolor,* has been observed in Bataan, Rizal, Laguna, and Batangas Provinces. A specimen has also been sent in from Surigao, in Mindanao. It is very serious in the highly cultivated groves, but is not found so commonly in the groves which are uncared for. In orchards where preventive measures are not practiced, this disease can be much more serious than psorosis. The injury resulting from the disease is shown in Plate 24. The control of the disease is very simple, as shown in experiments by Lee and Yates, reported in the Philippine Journal of Science for June, 1919; it therefore need not be regarded as seriously as psorosis, foot rot, or bark rot. Pink disease is also serious on cacao, coffee, rubber, acacias, and many other economic host plants.

Citrus canker.—This disease, caused by the bacterial organism, *Pseudomonas citri,* is now very nearly distributed thruout the entire Philippines. It is not serious here inasmuch as the varieties grown are largely resistant species. Occasionally, in a dooryard tree, a susceptible variety will be partially defoliated and the fruits badly blemished. Prevention of this disease in the Philippines is best accomplished by the planting of resistant varieties. A list of resistant varieties has been given by Lee in the Philippine Agricultural Review for the third quarter, 1918.

Citrus canker is not indigenous to the Philippines and may be classed as an introduced disease, probably from China, altho the initial introduction must have occurred in years past.

Wither tip of limes caused by the fungus Gloeosporium limetticolum.—This has been observed in Bataan and Batangas Provinces. Limes are not commercially grown here, however, and the disease is therefore not serious. This disease has not been previously reported from the Philippines.

Wither tip of grapefruit, and sweet orange trees.—This disease, caused by the fungus, *Colletotrichum gloeosporioides,* has been observed in Bataan, Laguna, and Batangas Provinces, but never causing serious injury.

Mottled leaf of citrus.—This disease which is considered physiological and nonparasitic, has never been observed by the writer upon seedling trees in the Philippines. It is very serious here, however, on trees budded upon pummelo stock. It causes no extensive injury at the present time, inasmuch as seedling trees are grown for the most part. Upon budded trees the disease may be easily avoided by the use of the proper stocks, as pointed out by Lee in the Philippine Journal of Science for January, 1921.

Greasy spot.—This disease, the cause of which is unknown, has been observed very commonly in the Philippines.

Sooty mold, a black surface fungus, *Meliola* species, is common in all citrus-growing provinces following the attacks of insects giving off honey dew. It is very rarely important in this country.

DISEASES OF THE BANANA PLANT (MUSA SAPIENTUM)

Banana wilt.—This disease caused by the fungus, *Fusarium cubense,* was found in Laguna and Batangas Provinces in June, 1920. It had not been previously reported in any place in the Philippines. It has also been observed in Occidental Negros and is probably well distributed thruout the country. It is sporadic in occurrence and will affect one plantation and escape many near-by plantations of the same susceptible variety. Affected plantations are not numerous but are very seriously hit when once affected. Mr. F. B. Serrano who has done the field work on this disease, reports it attacking chiefly the Latundan

PLATE XVIII

(See legend on list of illustrations)

(See legend on list of illustrations)

variety which is the most popular variety in central Luzon. There are several varieties which appear resistant. The disease has not been previously reported in Philippine literature.

Banana heart rot.—This disease causes a rotting of the terminal bud which extends down through the central cylinder, causing it to become black and giving off a disagreeable saline odor. To the writer's knowledge it has not been described as yet from other countries. It is quite common but does not cause extensive injury. The pseudostem may be cut off below the limits of infection and new suckers which arise are usually free from the disease. We have found it in practically all provinces of Luzon where bananas are grown.

Banana freckle.—This disease caused by the fungus, *Phoma musae,* was first described from the Hawaiian Islands, where, from its limited occurrence at first, and subsequent distribution, it was believed to be a disease of recent introduction. It was first found in the Philippines in Laguna Province and subsequently in Rizal, Batangas, Bataan, and Occidental Negros. In Mindanao and Sulu it has also been found to be widely distributed. It occurs on many varieties of bananas, including the Latundan, the wild banana, *Pacol,* and abaca plants. Because of its wide distribution in this country and the occurrence on our indigenous host plants in isolated parts of the country, it would appear as if the disease is of very long duration here and even indigenous, and it is quite possible that it was introduced into Hawaii from here.

The disease results in serious losses on the commercial varieties of bananas in the Hawaiian Islands since it causes an unequal ripening of the fruits in the bunches and also a blemish on the fruit. In this country, since bananas are not grown for shipping and unequal ripening causes no harm, it is not greatly important at the present time. Its appearance on fruits is shown in Plate 18.

DISEASES OF THE ABACA PLANT (MUSA TEXTILIS)

Abaca heart rot.—This disease is similar to banana heart rot just described, but much more prevalent. It is not a devastating disease by any means but takes a small percentage year after year from the total production of hemp. Inoculation experiments have shown it to be due to a fungus upon which we have not yet reported. The disease has been reported from the Provinces of Laguna, Cavite, Albay, and Davao. A root rot of abaca also exists, usually following the attacks of the root borer, *Cosmopolites* species. No studies have been made on this trouble as yet.

Several leaf spot diseases occur which cause little injury.

Marasmius root rot.—A root disease of abaca plants resulting in the death of the plants is occasionally seen in Cavite Province. Associated with the disease are occasionally seen fruiting bodies of a fungus of the genus *Marasmius*. The disease is not widespread and causes very little loss. It has not been reported previously.

A DISEASE OF SISAL AND MAGUEY (AGAVE SPECIES)

Anthracnose.—The disease caused by the fungus *Colletotrichum agaves* was first observed in May, 1921, in La Carlota, Occidental Negros, on what is called zapupe, *Agave zapupe,* and on sisal, *Agave cantula.* The disease is not widely distributed on sisal in the Philippines according to hemp inspectors, and is known only at La Carlota and one other small planting on the Island of Panay. Evidence points rather definitely to this disease as an introduction on zapupe plants from Mexico, within recent years. Zapupe does not occur and is not cultivated commonly in the Philippines. In recent years it was introduced from Mexico and inasmuch as the zapupe is very seriously affected and the sisal plants near by have also become affected, while sisal thruout the Islands is not affected, such occurrence would indicate that the disease had come into the country on the zapupe plants.

The disease is very serious on zapupe since an affected plant, altho it is not entirely killed, is destroyed for the purposes of fiber production; sisal plants near by are not so severely affected which may be due to their being more recently affected or possibly to less susceptibility. Maguey, also planted near by, is not severely affected and may be resistant. The appearance of the disease is shown in the photographs, Plate 19.

DISEASES OF PINEAPPLES, ANANAS COMOSUS (SATIVUS)

Pineapple wilt.—This disease has been found only in the Provinces of Bataan, Laguna, and Bukidnon, on but three plantations. It is found only on Hawaiian varieties; native plantings are either resistant or have not yet been infected. Mr. F. M. Clara has made a very extensive field survey for this disease and finds it in only these three localities. The evidence would indicate that it was of recent introduction, probably within the last six years; it has not been widely distributed throughout the provinces, and it should be possible entirely to eradicate the disease at the present time and maintain the country free of the trouble. Upon one plantation where the disease was found, the loss was

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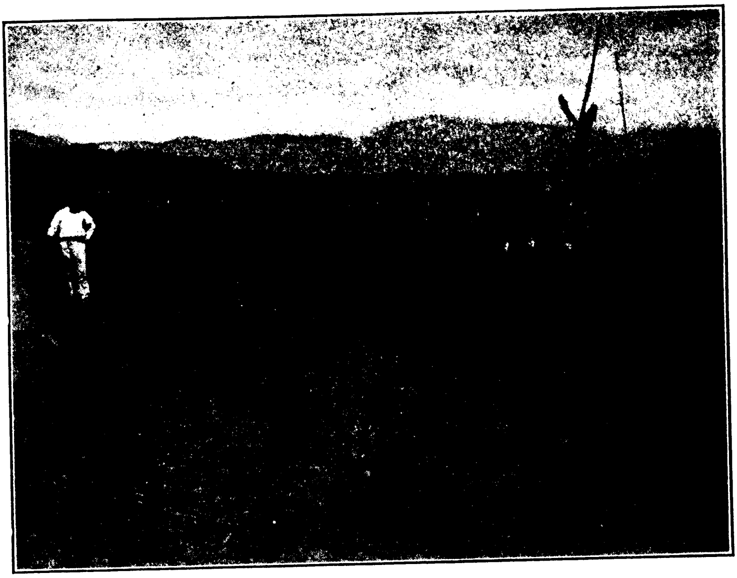

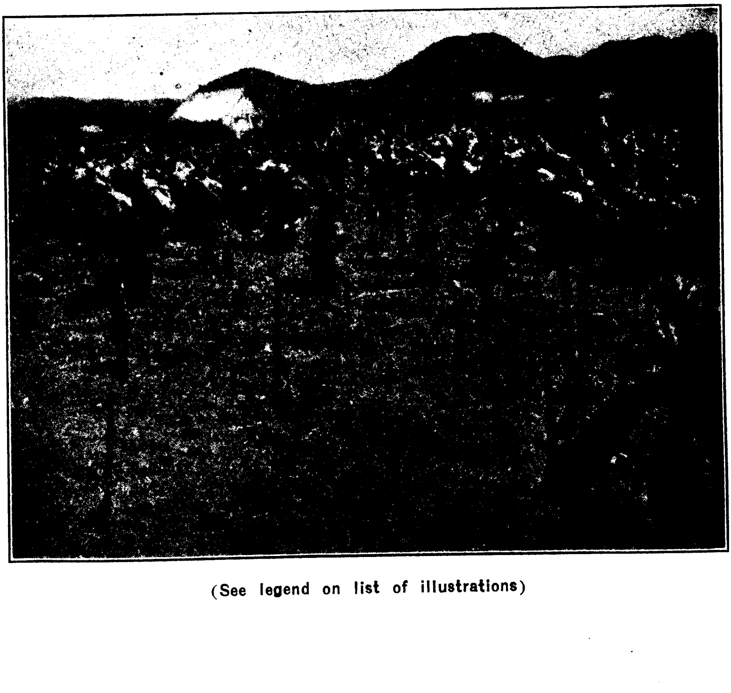

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fairly severe. This is the first mention of pineapple wilt from the Philippines. Affected plants are shown in the photographs, Plate 20.

Thielaviopsis rot.—This disease is very generally distributed where pineapples are grown in the Philippines. We have found the fungus, *Thielaviopsis,* on fruits, leaves, and suckers. In the total, it produces a considerable amount of loss which is impossible to present in any definite estimate. This disease altho very common has not been previously reported from this country.

DISEASES OF TOBACCO (NICOTIANA TABACUM)

Bacterial wilt.—This disease, due to *Bacterium solanacearum,* occurs here but in our limited experience has not caused extensive injury.

Root rot.—This is the worst disease of tobacco in the field in our experience. According to Mr. F. M. Clara who has done the field work on the disease, it occurs late in the season and is very generally distributed and causes serious loss. We have isolated a fungus uniformly from the disease which we believe to be *Thielavia* but so far have been unable to cause it to fruit. The disease has not been previously reported from this country and apparently has been confused with bacterial wilt; its effects are shown in Plate 21.

Sclerotium disease.—This disease, due to the fungus *Sclerotium rolfsii,* is found not only in the seed beds but also in the fields under foothill conditions. It does not cause general injury but causes a sporadic picking off of five to ten plants in a whole field. Root rot, on the other hand, will kill extensively in large patches. *Sclerotium* disease has not been serious in our experience on the lowlands due, we believe, to the longer dry season. This fungus has not been mentioned previously in the literature as causing a field disease of tobacco, to our knowledge.

Cercospora leaf spot.—This disease is usually found upon old plants especially at the end of the season when the rains begin. The loss was, however, negligible during the last season.

Mosaic disease.—This disease, altho affecting a very large proportion of the tobacco plants which reach maturity in the Philippines, has never been previously reported from the Philippines to the writer's knowledge. The disease is highly infectious and is caused by what is called a filtrable virus. Young plants do not show the infection, but after the first picking of the leaves the disease shows up uniformly, apparently having been disseminated by the pickers. There are no complaints of losses from this disease and apparently the growers have not recognized the losses from it as yet.

DISEASE OF THE COCONUT (COCOS NUCIFERA)

Bud rot.—This disease is very widespread and there are numerous complaints of injury resulting from it. No active investigation of this disease has been carried on in this laboratory inasmuch as it has seemed desirable to concentrate on other diseases. Bud rot is reported from all the largest coconut producing districts of the Philippines. An eradication campaign against the disease has been carried on by the Bureau of Agriculture.

Pestalozzia leaf spot.—This leaf spot disease, caused by a fungus, *Pestalozzia palmarum,* is very widespread, having been sent in from almost every coconut-growing district of the country. In the writer's experience it apparently is of importance only on the young trees, and with age little injury results from the disease. On young trees it frequently causes alarm to growers.

Stem bleeding disease.—This disease, described from Ceylon, has previously been unreported in the Philippines. It occurs in Mindanao and Sulu, but the writer's observations of the coconut regions on Luzon have been limited so that it is impossible to make a statement as to its presence here. In Mindanao it is a considerable factor, resulting in a shorter length of life of the trees.

DISEASES OF SUGAR CANE (SACCHARUM OFFICINARUM)

Pineapple disease.—This disease, caused by the fungus *Thielaviopsis paradoxa,* is of widespread distribution throughout the Philippines. Although it is easily preventable, a great deal of loss results from this disease.

Many fields have been observed which had to be entirely replanted or which were entirely abandoned due to lack of germination of the seed caused by this disease, Plate 22. Such loss is in most cases entirely unnecessary. The first report of the disease in this country by Lee in the *Philippine Sugar News* for August, 1920, gives a short account of methods of prevention.

Cane smut.—This disease caused by the fungus *Ustilago sacchari* is also of widespread distribution on Luzon. It affects especially the Luzon White and Pampanga Red varieties. The varieties, Yellow Caledonia, H-109 and Louisiana Striped have not been observed to be affected. The disease, since it increases with ratooning, is one of the factors which limits ratooning of susceptible canes on Luzon. Inasmuch as the varieties Pampanga Red and Luzon White have been the most commonly grown on Luzon, ratooning of cane has not been generally practiced here. Ratoon fields in which four out of five plants were affected, have been observed. The disease may be prevented by the use of resistant varieties and such serious loss appears to be entirely unnecessary.

Rind disease.—A fungus known as *Melanconium sacchari* was described in the early days in the Hawaiian Islands and the West Indies as the cause of what is known as rind disease. Since that time, however, further work of Dr. H. L. Lyon of the Hawaiian Sugar Planters' Association has shown that this fungus is not parasitic, but attacks only canes killed previously by other causes. No injury due to this fungus has been observed by us; nevertheless, previous writers in this country, unaware of the literature, have repeatedly made the mistake of describing rind disease as a serious trouble of the cane.

Sclerotium disease.—This disease, also known in Java as red rot of the leaf sheath, caused by the fungus *Sclerotium rolfsii,* is found very commonly in this country. There is no data available showing the extent of injury, but apparently under ordinary circumstances it is unimportant.

Top rot.—A disease which we consider similar to top rot, described in 1890 by Wakker from Java, is found here. We have isolated a fungus from this disease which upon reinoculation has produced the primary symptom of it. The disease is sporadic only in occurrence and causes negligible loss. Mr. M. G. Medalla has assisted the writer with this disease.

Mosaic or yellow stripe disease.—This disease is of widespread distribution and general prevalence, and these facts lead to the conclusion that it is of long duration in this country. The disease apparently causes a large percentage of loss from the total production of this country, but as yet there is no detailed data to show definitely how great the losses may be. We find the disease very common upon the Luzon White and Pampanga Red varieties, and also upon Louisiana Striped but with less stunting effect than on the native canes. Yellow Caledonia is not commonly affected but when affected seems to be very severely stunted. It is difficult to find a stool of the Luzon White in a ratoon field which is not affected. The same holds true for most fields of plant cane of this variety after about six months.

The Pampanga Red variety is not so commonly affected. In Negros some plantations have it on almost every stool, while other districts are entirely free from it. The considerable loss caused by this disease can be easily avoided and is apparently unnecessary.

Rust.—This disease, caused by the fungus *Puccinia kuehnii,* has been found rather commonly on Louisiana Striped, Rose Bamboo, and Black Cheribon varieties but causes slight injury. It is apparently the most common on these varieties and causes but little injury on other varieties.

Wilt.—This disease, caused by the fungus *Cephalosporium sacchari,* was sent in to the laboratory from Mindoro Province. It has been reported previously only from India and the Union of South Africa. The fungus which was isolated proved the identity of the disease. It is not of widespread occurrence but causes entire killing of a cane when once affected. In the writer's experience it occurs only sporadically. This is the first report of the disease in this country.

Roots disease due the fungus, Marasmius sacchari.—This disease has been observed here but has not caused extensive injury in our experience.

Leaf spot cauesd by the fungus, Bakerophoma sacchari.—This disease has been found on the Louisiana Striped cane most commonly. The disease, in our experience, has caused very slight harm but it is apparent that it has possibilities of doing greater harm under favorable conditions.

Ring spot.—This leaf spot disease, caused by the fungus *Leptosphaeria sacchari,* is widespread in Batangas, Laguna, Rizal, Bulacan, Pampanga, Occidental Negros, and Zamboanga Provinces. Under seasonal conditions favorable for the fungus it may cause tangible injury in decreasing the leaf area. Because of its wide distribution and importance to the planters it is peculiar that it has never been reported from this country previously. The disease may be avoided by planting resistant varieties such as D-1135 and Badilla.

Leaf spot due to the fungus, Phyllachora sacchari.—This disease was collected by Mr. G. M. Reyes in Mindanao, where he found it rather commonly on the native canes grown for chewing purposes. It is rare or entirely absent in the commercial cane varieties of Luzon and Occidental Negros.

Leaf spot due to the fungus, Cercospora kopkii.—This leaf spot is very common on H-109 cane and has been observed by Messrs. Medalla and Reyes in Bataan, Rizal, Laguna, and Occidental

Negros Provinces. It has not been observed on the native varieties, Luzon White, Pampanga Red, and Negros Purple. It has not caused serious loss in our experience; from the data available it would appear to have been long existent in this country. Our identification of the fungus is tentative only as we would like further study to assure our identification.

Leaf spot due to the fungus, Pestalozzia fuscescens var. sacchari.—This leaf spot disease was collected by Mr. G. M. Reyes from Mindanao on the native canes grown for chewing purposes there. It is not present or at least is not common on Luzon and is of no importance on the commercial cane varieties at the present time. This disease has not been previously reported from this country.

Leaf killing disease due to the fungus, Colletotrichum, falcatum.—This disease was observed in a restricted area only in Pampanga during a period of warm weather with frequent showers. The leaves were reddened and subsequently browned and killed. Fruiting bodies appeared which on examination evidenced the presence of the fungus *Colletotrichum falcatum.* This fungus is most noteworthy in literature as causing a disease on the stem known as red rot, altho it has also been previously described from other countries as a leaf killing fungus. Red rot of the stem has been frequently reported from the Philippines but in the writer's experience has never been observed. The killing of the leaves due to the red rot fungus has not been previously reported upon here.

With a change in the weather causing drier conditions the disease disappeared. It is apparently not of great importance in this country.

Sooty mold.—This disease, due to the fungus *Meliola arundinis,* occurs on the leaves of cane following the attacks of aphids. It is quite common but causes negligible loss in our experience.

Banded sclerotial disease.—This disease described from India and Java has been collected by Mr. E. Villavicencio and Mr. G. M. Reyes in two localities in Rizal Province. The causal fungus has no spore forms. It is usually on the older leaves and is not conspicuous; close examination will probably demonstrate it well distributed thruout the other provinces. It has been found on Louisiana Striped, Badilla, Barbados, and Luzon White varieties. This is the first report of the disease from this country.

Root disease due to the flowering parasite, Aeginetia indica.—A disease exists in Laguna, Batangas, and Rizal Provinces on mature or nearly mature cane which causes an almost complete loss of the sugar in the cane and a consequent loss of the crop; ratooning following the attacks of the parasite is of course impossible. This injury is due to a parasitic flowering plant, *Aeginetia indica;* the parasite is found on cane commonly in Rizal, Laguna, and Batangas Provinces; it is also reported on other grasses in Pampanga Province by Dr. E. D. Merrill.

It has not yet been reported from Negros to our knowledge. Very little is known about the dissemination of this parasite and the conditions favorable for its development and, consequently, its prevention is very difficult. This is one of the most disastrous diseases in the Philippines when it does occur, but fortunately it is not common outside of Laguna and Batangas.

Downy mildew or leaf stripe.—This disease caused by the fungus *Sclerospora sacchari* was introduced into Rizal Province from Formosa, in 1920. Upon the discovery of the disease, the affected cane, about one hectare in extent, was promptly cut and burned and the stubble dug up and burned over. Since then continued inspection of the field has been maintained, but the disease has not as yet reappeared.

Another outbreak of the disease covering several hectares, was observed at one of the new mills in Pampanga Province. The source of this infection is not known. This outbreak has been in the hands of the mill staff who have undertaken to eradicate it. With its complete eradication in Pampanga the disease should be entirely absent from the Philippines.

Fiji disease.—This disease, the cause of which needs considerable further study, is present in Laguna, Batangas, Mindoro, and Occidental Negros Provinces. A few cases where observed at Del Carmen, Pampanga, which were promptly eradicated, and that province is free of the disease for the present. A case has also been forwarded from Zamboanga, in Mindanao. This disease is undoubtedly the most serious on sugar cane in the Philippines. It is of recent introduction, its history in the Philippines being fairly easily traced. It has not been in the country more than ten years, but in that period has become so widely disseminated as to be beyond the possibility of isolation.

Red vascular disease.—There has been observed at Lamao, Bataan; Alabang, Rizal; Carmencita, Pampanga; in Mindoro and sparsely distributed thruout Occidental Negros a disease which we are calling red vascular disease characterized by a wilt of the leaves and by reddened vascular bundles. The disease is distinct from the published description of sereh in that there is no mention of a wilt of the leaves in the case of sereh,

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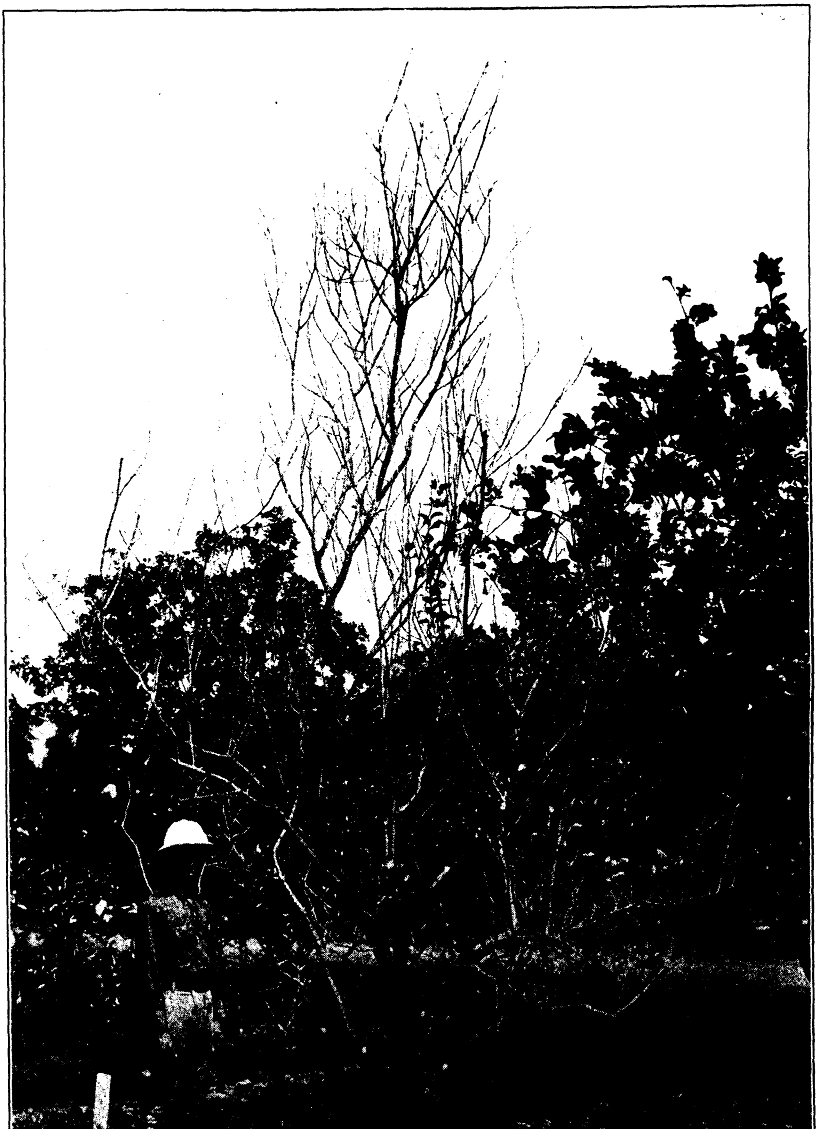

(See legend on list of Illustrations)

nor is there in the case of this Philippine disease the profuse stooling of the affected canes as described for sereh in Java. The disease is most common on H-109, altho it has also been observed on Louisiana Striped and Negros Purple. Inasmuch as Negros Purple is said to be very resistant to sereh in Java this constitutes another reason for believing it to be distinct from sereh. The disease is also quite distinct from wilt and red rot, either of which from the written description might be confused with this trouble.

This Philippine disease is apparently identical to a trouble shown to me by Dr. H. L. Lyon of the Experiment Station, Hawaiian Sugar Planters' Association, which occurred at Olaa, Hawaii, on D-1135 variety. The disease could be easily eradicated in the Philippines at the present time with little or no financial loss to the planters, and this procedure will probably be undertaken. The effects of this disease on young cane are shown in Plate 23. The true Java sereh has been repeatedly reported from this country but such reports have not been correct.

Root disease.—The mention of a root disease caused by the fungus *Dictyophora phalloidea* has frequently been made in Philippine literature. This class of fungi was given considerable mention as cane parasites in the early days of experimental work in the Hawaiian Islands. More recent work there has shown this group of fungi to be entirely harmless and not parasitic. In our observations in the Philippines, *Dictyophora* has never occurred in such a way as to give the impression of its being parasitic on sugar cane. It would seem to be more nearly the case, as in Hawaii, that this fungus on cane is a harmless saprophytic organism.

DISCUSSION

The foregoing brief account has listed some of the more important economic diseases which have come to our attention. Twenty-two of these diseases are here reported for the first time in the Philippines. Of the diseases listed there are several which are apparently not completely distributed throughout the Philippines and the dissemination of which should be prevented. Such a case is pink disease, which has not yet been observed on the Island of Basilan. There are two rubber plantations, neither of which has ever had a single case of pink disease to the present time, although in other countries this disease on rubber constitutes a considerable handicap and occasions a constant prevention campaign. Pink disease is present in Luzon and also has been found in Sorsogon. The greatest care should be taken to keep this disease out of Basilan.

Pineapple wilt is at present restricted to three localities in the Philippines; Abucay, Bataan; Los Baños, Laguna; and Diclom, Bukidnon. Injury from this disease can be entirely eliminated by its complete eradication from the small areas now affected.

Anthracnose or black spot of sisal and zapupe is another disease at present not widely distributed. Restriction of the distribution of sisal plants from Occidental Negros and Panay would restrict this disease at least temporarily. Losses from the diseases downy mildew and red vascular disease of sugar cane can also be entirely prevented at the present time by the entire eradication of the small amounts of cane at present affected with these diseases.

The number of diseases for which there is considerable evidence pointing to their recent introduction is also noteworthy. Such diseases are citrus canker, bark rot on citrus, anthracnose of sisal and zapupe, pineapple wilt, Fiji disease of sugar cane, and downy mildew of sugar cane. Each one of these diseases is a limiting factor in the commercial production of the crop which they attack. Each of them could have been easily and cheaply prevented by greater care in the importation of plants from foreign countries. A very discreditable feature of these disease introductions is that in the majority of cases, they were introduced by individuals closely associated with agricultural institutions or large, specialized agricultural industries.

When it is considered that in the case of the least destructive of these diseases an appreciable percentage from the yields is lost, that such loss affects the yields from the whole country, and that such decreased yields are repeated year after year, it becomes evident that ignorance or negligence, allowing the introduction of plant diseases, costs the country, eventually, millions of pesos.

INJURY TO CITRUS BY SCALE INSECTS IN THE PHILIPPINES

By H. E. Woodworth

Professor of Entomology, College of Agriculture, Los Baños

The citrus industry in the Philippines, while now of rather minor importance, offers in several localities at least, a large commercial possibility. Wester[1] states that "there is unquestionably a bright future for the cultivation of the mandarin, orange, pomelo, lime and to some extent the calamondin." The Philippines import large amounts of citrus fruit which ultimately should be supplied from local production. Before this condition can possibly be brought about, however, several important problems connected with the culture of the fruit must be solved. Not the least among these are those relating to the prevention of loss through insect injury.

In all countries where citrus is grown commercially, scale insects (*Coccidae*) play an important role in the industry. The specific amount of the direct or primary injury occasioned by these insects is often difficult to prove and for this reason the importance has been at times in many localities, including the Philippines, greatly underestimated. On the other hand, there is the danger of giving undue importance to scale infestations which, though sometimes heavy, do not materially affect the trees. The relative importance of the scale, therefore, under the conditions which obtain in a given locality must be definitely demonstrated before the economy of control can be shown.

The observations from which the conclusions of this paper are drawn were made in the various citrus plantations of the College of Agriculture at Los Baños, Laguna, and the results noted must therefore be considered as primarily applicable to that place, although observations in other citrus growing sections of the Philippines tend to show that the statements apply to the Islands generally. While complete notes are available on only one scale species, *Coccus viridis* Green, so far as the Philippines are concerned, the conclusions apply equally well with the other important citrus scales. This scale was selected for various reasons, the most important of which are: first, its great variation in seasonal abundance; second, its susceptibility to the attacks of parasitic fungi; third, the high per cent of scales parasitized by insects during certain seasons; and fourth, its general distribution and omnivorous habits.

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[1] Wester, P. J., Bureau of Agriculture Circular No. 24, August 15, 1913, pp. 1–21.

Secondary injury from scale insects, such as smutting of the fruit, while of vast importance in some countries, notably California where the black scale (*Saissetia oleae* Bern.) because of the smutting, is by far the most important citrus pest, is relatively unimportant here and will not have to be considered until the buying public demands graded and selected fruit. Scale infestations of the fruit itself are likewise unimportant at this time. For the present, scale insects damage to citrus in the Philippines is confined to the direct or primary injury.

The primary or direct injury from scale insects consists in the loss of the plant juices through the sucking habits of these pests. Normal plants show no serious effects of scale attack when cultural conditions are good and sufficient moisture is present in the soil, unless they appear in overwhelming numbers. Infestations of *Coccus viridis* or other scales on citrus have rarely been observed in such numbers here other than in the hot dry season. In the plantations of the College of Agriculture citrus is grown without irrigation, as is the case throughout the Islands. From December until May the rainfall is slight (figure 1) and the soil becomes depleted in moisture until, toward the end of this period, the trees suffer severely from drought. At the latter part of the same period the plants have also to endure the hottest season of the year (figure 1). Woodworth[2] states that "No class of injury renders a plant less able to pass through a drought than does that caused by sucking insects." It is quite evident that the additional burden placed on the plant by scales at this period would definitely affect its condition.

While the same numerical infestation throughout the year would be vastly more harmful to the plant during the dry season, the greatly increased infestation which actually does occur during the "drought" season multiplies the damage many fold. On four young trees of *Citrus grandis* Osb., scales were counted monthly. Those exhibiting fungus attack were not included in the totals, nor were those which showed exit holes of insect parasites, thus eliminating those which were no longer attacking the plant. The figures as plotted in figure 1 show a minimum number of scales present in October and November, slowly increasing until April and then dropping off in numbers rather rapidly at first during the extreme end of the hot season and through the wet season to October. Comparing the graphs in figure 1, it is evident that the heavy infestation of scales occurs through the driest part of the year and at the same time the warmest season, a combination of circumstances which offer the greatest possiblity for damage from scale insects and is strikingly shown by the condition of the trees at the end of that period.

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[2] Woodworth, C. W. University of California Circular No. 7, 1903, p. 9.

No effort is made here to distinguish between the effectiveness of the various parasites and the climatic conditions responsible for the seasonal abundance of the scale. However, it is worth noting that, in a general way, the relative abundance varies directly with the average temperature and inversely with the average rainfall, the extremes occurring after those of temperature and just previous to those of rainfall. This may or may not be significant, and of course, may vary somewhat with other years. It is observed, however, that the period of effectiveness of parasitic fungi is only during the rainy season, the fungi appearing on new scales and becoming effective from August to November and then falling off in numbers, until in March few recently parasitized scales are to be found. The most common parasitic fungus is the conspicuous red fungus (*Microcera coccophila* Desm.), while *Ascherontia sclerotoides* P. Hern; and *Septobasidium* spp.[3] occurs on the scale to a less extent.

Parasitic insects are undoubtedly a large factor in the seasonal cycle of *Coccus viridis* and other coccids on citrus here, but the maximum effectiveness is not apparent until well along into the rainy season after the harm by the scales has already been accomplished. The highest per cents of parasitisms were recorded in July, August, September, and October, while the period of maximum scale abundance and injury occurred in March, April, May, and June. Combining the effective periods of control exercised by insect and fungus parasites, there is still remaining those months of the dry season at which insects which suck the juices of plants, including scale insects, are able to do their greatest injury to plants.

Coccophagus sp. and *Aneristis* sp., two species of *Aphelinidae* hymenoptera, were bred from *Coccus viridis* and are the principal insect parasites affecting this species here. The determi-

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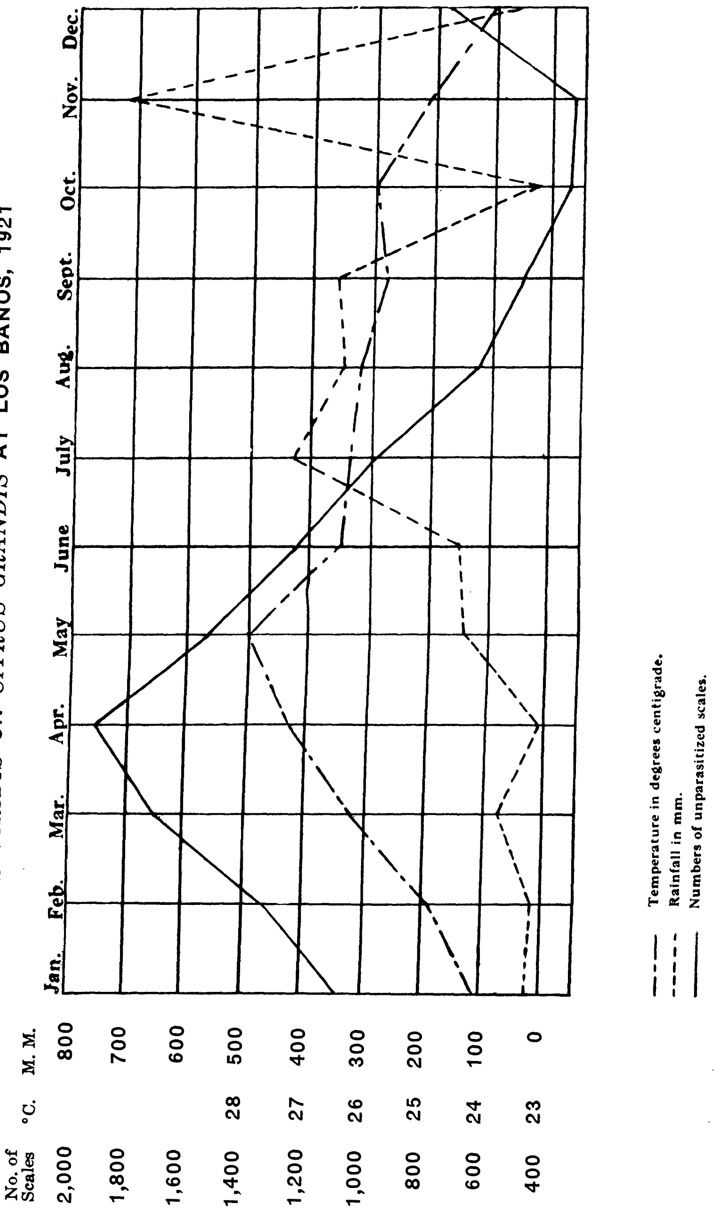
[3] Dean C. F. Baker offers the following comment: "It is a question if *Septobasidium* is actively parasitic. The pellicle formed over scales seems to feed largely on honey dew, since perfectly healthy colonies occur under the pellicles."



GRAPH SHOWING TEMPERATURE, RAINFALL, AND NUMERICAL ABUNDANCE OF *COCCUS VIRIDIS* ON *CITRUS GRANDIS* AT LOS BAÑOS, 1921

Fig. 1

nations for these were received from Mr. P. T. Timberlake of the Experiment Station of the Hawaiian Sugar Planter's Association, with the note that *Coccophagus* sp. was probably a new species and that possibly *Aneristis* sp. was also.

SUMMARY

1. The degree of primary injury from scale insects is in general directly relative to the condition of the plant.
2. Scales are most numerous during the dry season. (January to July in Los Baños).
3. During the dry season the scales receive the minimum natural check.
4. The injury from their attack is greatly enhanced by the poor resistance of the trees at this time.
5. Parasitic fungi are most effective from August to January.
6. Insect parasites are most effective from July to November.
7. *Microcera coccophila* Desm., *Ascherontia schrotoides* P. Hern. and *Septobasidium* spp. are the parasitic fungi found attacking *Coccus viridis* Green.
8. *Coccophagus* sp. and *Aneristis* sp. are the principal insect parasites of *Coccus viridis* Green.
9. Spraying or fumigation is a necessary supplement to the natural checks, as they now occur, for the control of the injury from scale insects on citrus in the Philippines.

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